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Experiences from the international frontlines: An exploration of the perceptions of airport employees during the COVID-19 pandemic

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ABSTRACT

The aviation industry is one of the sectors that has been heavily impacted by the pandemic. While the major body of literature has focused on passenger experience and behaviour, this study focuses on airport employees instead—their experiences, perceptions, and preferences following the emergence of COVID-19. More than 1000 participants from 4 major airports—Amsterdam Airport Schiphol, Singapore Changi Airport, Taipei Taoyuan Airport, and Zurich Airport—representing over 10 different occupations, have provided a variety of sentiments about the airport as an employment ecosystem in the wake of COVID-19. Quantitatively and qualitatively surveying four different airports enabled a cross-border analysis of the results to identify interesting geographic contrasts, as well as global themes, among the responses. Regional differences regarding, the feeling of preparedness, confidence in measures, and optimism are presented. A significant difference in confidence in non-pharmaceutical measures between employees from Asian and European airports is shown. Wants and needs such as better physical/IT workplace infrastructure and more flexibility regarding job scope and hours are pointed out. The results of this research provide insights for future airport employee experience research by outlining areas to study in greater detail. Furthermore, practical implications for airport stakeholders and companies arising from the challenges experienced by the workforce are laid out to provide guidance to prepare for similar circumstances in the future and navigate the aftermath of and recovery from the pandemic.

1. Introduction

As the COVID-19 pandemic continues to impact lives and livelihoods across the globe, researchers from all disciplines use their expertise to analyze impacts and implications, propose solutions to problems that arose, and detail mechanisms to deal with future disease outbreaks. Unsurprisingly, transportation (more specifically air transportation) research is among the fields abuzz with a flurry of publications—referred to by Sun et al. (2021) as a paper hurricane. In this "unprecedented biopsychosocial crisis" (Zagury-Orly and Schwartzstein 2020), commercial air transport has been hit hard by its role in the spread of the disease, the resulting border closures, and therefore the drastic reduction in passenger numbers. Being a source of employment for people with numerous professions, Singapore's Changi Airport, for example, employs over 50,000 people across roughly 200 different companies, the impacts on the civil aviation sector affect a sizable portion of residents in the world's cities.

Traditionally, or rather before COVID-19, those working at airports (hereafter simply referred to collectively as airport employees) and their experiences did not appear to be a popular subject in research literature (Tuchen et al. 2020). Only the field of airport security features several studies focusing on the respective employees and their behaviour—given the importance of human factors on overall airport security (see e.g. Hofer and Wetter 2012; Chung et al. 2017; Ghelfi-Waechter

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et al., 2019). Kirschenbaum (2015), for example, posited that human behaviour in security operations is never as neat as the processes designed—from a perspective of engineering mass processing—around it. The pandemic, however, has brought to the forefront the issues revolving around other employee groups (Fine et al., 2020). In May of 2021, reports of personnel from Singapore's Changi Airport being at the centre of the spread of the B.1.617 variant of SARS-CoV-2 in Singapore surfaced (Chew 2021; Lai 2021). Similarly, mass quarantines for Taiwanese flight crew (Brett 2021; *CNA* 2021), began drawing more attention to the people employed at air transport hubs. Airport staff are both at increased risk themselves, while at the same time posing a risk to their respective community given their exposure to travellers from all over the world.

While airport employees have mostly been featured in news reports about the latest developments, studies on hospitality employees have been published in the respective research journals. Like their counterparts from the hospitality industry, airport employees could be considered "forgotten frontline employees" (FLEs), as they are generally not as prominently featured as first responders and medical personnel (Voorhees et al. 2020), although they are dealing directly with the general public. As an additional similarity, the hospitality industry has also been suffering from the economic impacts of the pandemic. Hospitality workers have been studied in particular with regard to their career optimism and pandemic-induced stress (Manoharan et al., 2021; Wong et al., 2021), as well their safety behaviour (Du and Liu 2020; Kim et al. 2021).

Considering airport employees' unique positioning at the international front lines of the pandemic they form a noteworthy target group for research studies for a variety of reasons, safety behaviour being one example. However, factoring in the value of user experience for strategic planning (Tuchen et al. 2020), when regarded as airport users, they have the potential of being a valuable source of information via their perceptions and experiences. Hamid (2019) argued that human resource management (HRM) plays an important role in a world commonly associated with the US Army-invented acronym VUCA (Volatile, Uncertain, Complex and Ambiguous)(Bennett and James Lemoine, 2014), going as far as highlighting the importance that a properly managed and supported workforce has for the performance and stability of an organization. Airports are particularly complex because of the large number of companies (with individual workforces) involved, requiring alignment of policies and measures across the board. The COVID-19 pandemic embodies all four letters (Tooze 2020) and understanding the workforce within this context could provide key insights for managerial decisions.

We distributed a questionnaire survey at 4 major airports, 2 in Europe, and 2 in Asia. Given the global spread of airports (and the pandemic), we aimed to observe differences in perception between different countries/regions, in this case Europe (the Netherlands and Switzerland) and Asia (Singapore and Taiwan), as well as similarities. As opposed to targeted studies in the hospitality sector, for example those done by Du and Liu (2020) or Wong et al. (2021), our research set out to explore the pandemic reality and experiences of airport employees in broader terms—both qualitatively and quantitatively. Providing an overview over the situation airport employees were thrust into and outlining areas for organizational action is intended to be the first step in paving the way for more adaptive—and thereby resilient—corporate structures, thus fostering a safe work environment for both airport employees and other forgotten FLEs. As such, in this paper we address the following questions.

1. What communication channels did companies use to inform their employees about the pandemic and the implemented measures? How prepared did employees feel and how did they perceive the appropriateness of the measures?
2. What levels of confidence do employees have in common non-pharmaceutical disease prevention measures at the airports involved in this study?
3. What do employees perceive as particularly challenging and what are their specific wants and needs during a pandemic?
4. How do the employees perceive the pandemic impact, their own job security, and what is their long-term outlook?

2. Methods

2.1. Survey conception and data collection

A web-based survey was designed to capture the perceptions and experiences of airport employees during the pandemic. Given the novelty of the COVID-19 situation and the sparseness of broader airport employee experience research, much of the questionnaire was developed through discussions between the researchers and input from industry insiders, Changi Airport Consultants and the Royal Schiphol Group (RSG), and the airport division of the Zurich State Police. Compared to targeted surveys involving airport employees, such as the aforementioned security employees, our questionnaire contained more open-ended questions and covered a wider of issues, such as, impact and perceived job security, challenges, measures taken and the mode of preparation for these, confidence in measures, communication with the employer, and fear of infection, among others.

The data obtained deliberately focuses on the perceptions of the airport employee sample, rather than self-reported behaviour. This was to avoid social desirability bias in the responses, especially in relation to adherence to pandemic measures (see e.g. Selb and Munzert 2020). Instead, understanding the perceptions and experience of employees was chosen as a valuable approach to identify issues of importance for short- and long-term managerial efforts. Most survey items were assessed using 5-point Likert scales, while open ended questions were used to capture latent wants and needs, as well as personal coping strategies. The survey was published in English, German, Dutch, and Chinese (simplified & traditional) to accommodate all participants at the respective airports and avoid a bias towards those who speak English. Distribution was handled through the researchers' connections to airport stakeholders at Amsterdam Airport Schiphol, Singapore Changi Airport, Taipei Taoyuan Airport, and Zurich Airport, from October to December 2020. No incentives were offered to participants.

Airport stakeholders in Singapore and Zurich distributed the survey directly to their employees via emails and QR codes, while in Amsterdam, the Royal Schiphol Group (RSG), sent out emails to its stakeholders and distributed the survey via the staff intranet, bulletin boards, and emails. In Taiwan, the survey was hosted in online forums for employees. This resulted in a total of 1017 valid responses.

2.2. Data analysis

This paper—as outlined in the introduction—focuses on the following: areas of interest 1) *communication and preparedness* (3.2), 2) *confidence in measures* (3.3), 3) *challenges, wants, and needs* (3.4), as well as 4) *impact, job security, and outlook* (3.5). Statistical analyses were performed using R (version 4.0.2). The Kruskal-Wallis test was used to compare samples followed by the Wilcoxon signed-rank test to investigate paired differences. Ordinal logistic regression models were built to investigate association between independent variables, and Likert scale responses. In the isolated case of quality of information (comprising Likert scale responses for consistency of information, timeliness of information, and usefulness of information), where it was hypothesized that the quality of information directly and positively influences the feeling of preparedness for measures/procedures, a simple structural equation model (SEM) was employed. The measurement and structural model were built using the Lavaan package in R. The maximum likelihood method of estimation was utilized to analyze the data. For

comparisons between countries, the place of employment, i.e., the airport, of the respondents was used rather than their nationality and the respondents working at "other" airports (n = 6) removed.

The survey contained the following open-ended questions.

1. What are particular challenges at work for you personally during this time?
2. What are things that you would have liked to make your job/work more comfortable and productive during the pandemic?
3. Do you have any personal coping techniques/strategies for the current pandemic situation?

There are two commonly used approaches to perform qualitative data analysis on the responses from these 3 questions: deductive and inductive coding. Code or coding in this context refers to the labelling or categorizing of quotations from respondents and organizing these according to their content. When using deductive coding researchers have a predefined coding scheme or set of labels that is being applied to the data; inductive (or open) coding (see e.g. Azungah 2018), on the other hand, means that the codes—or labels—are derived from the responses themselves. Given that the study was exploratory, the latter option, more specifically inductive thematic analysis, was chosen, i.e., "coding the data without trying to fit it into a pre-existing coding frame, or the researcher's analytic preconceptions" (Braun and Clarke 2006).

After the responses were cleaned to exclude responses such as "N/A" and "nil", the inductive thematic analysis was performed on the remaining 527 quotations by 318 individual respondents (31.3% of respondents). The open coding yielded 85 codes in the first round of coding by one researcher. These were subsequently consolidated into 64 codes, after a second round of coding involving a second researcher and reaching a negotiated agreement. If a focus is placed on interpreting the data, researchers using an inductive approach have been reported to omit calculating any form of intercoder reliability (ICR), especially if researchers are also concerned about issues such as "false precision" (Campbell et al., 2013; O'Connor and Helene, 2020). However, as we also considered the frequencies of themes, we opted to perform an ICR assessment as is suggested as good practice by O'Connor and Helene (2020). 25% of the data (recommended by O'Connor and Helene, 2020), randomly selected, was coded again by a third researcher. The calculated Krippendorff's alpha of 0.83 indicates sufficient reliability (Krippendorff 2004).

With intercoder reliability established, the 64 codes, or tags, were subsequently assigned to 13 themes in 3 theme-groups (Fig. 1). Based on the themes, the responses to the 3 open-ended questions were used to provide a qualitative dimension to three of the four areas of interest outlined in the introduction, making full use of the flexibility of thematic analysis (Braun and Clarke 2006). This is done by highlighting the most frequent themes and providing concrete examples (given with respondent number and quotation number of that respondent, e.g. (100:1) for the first quotation of respondent 100). Under *communication and preparedness* (3.2), responses/themes from the second open-ended question are used to provide further insights, for *challenges, wants, and needs* (3.4) the first and second open-ended questions are used, and for *impact, job security, and outlook* (3.5)the third open-ended question is used.

3. Results

3.1. Sample characteristics and overview

In total, 1017 responses from four international airports were received with a good balance between the number of responses from each airport: 265 from Amsterdam Airport Schiphol, 225 from Singapore Changi Airport, 302 from Taipei Taoyuan Airport, and 208 from Zurich Airport. The 6 respondents who were employed at "other" airports were not included in the analysis. The completion rates were as follows: 81.54% at Amsterdam Airport Schiphol, 94.54% at Singapore

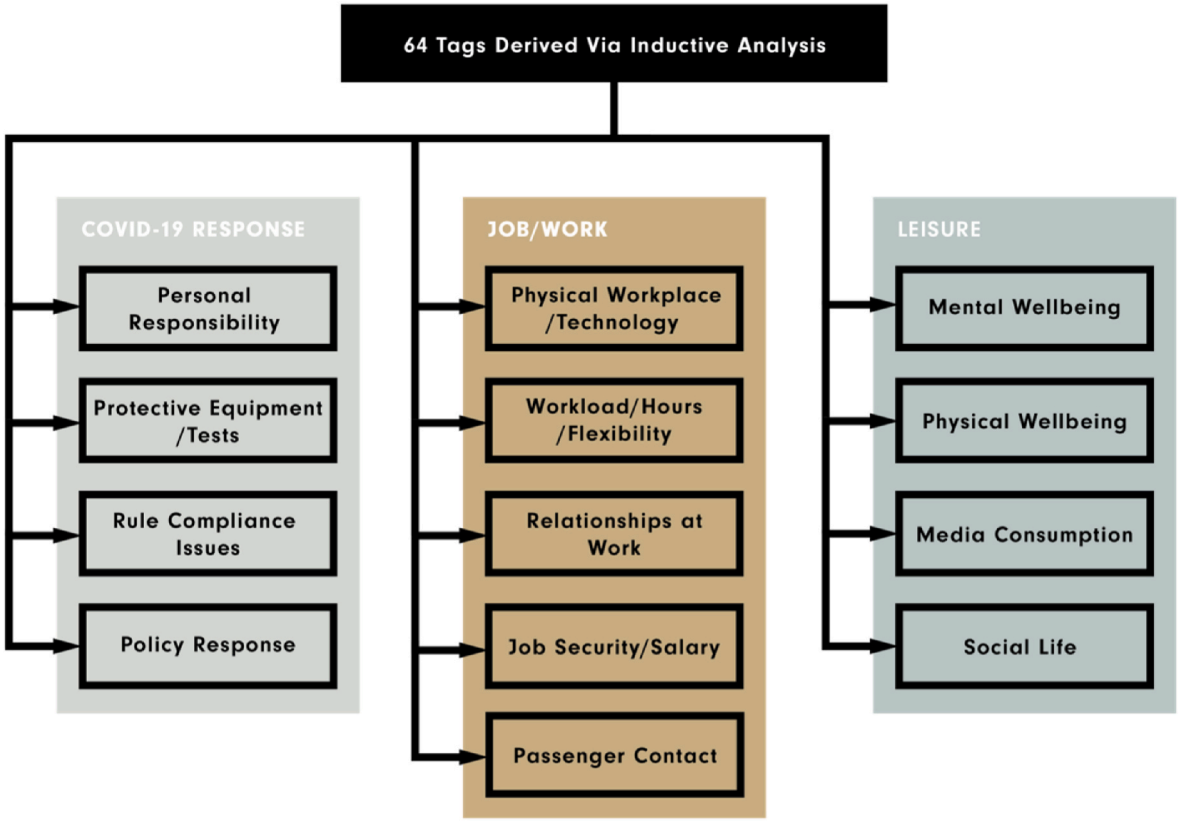

Fig. 1. Overview of themes derived from the answers to the open-ended questions.

Changi Airport, 90.15% at Taipei Taoyuan Airport, and 93.27% at Zurich Airport.

Sample characteristics for the total dataset as well as each airport are summarised in Table 1. The shares of female and male respondents were almost equal. As can be expected of a working population, the majority of respondents (77.3%) is aged between 25 and 54.

Airport employees are from a diverse range of roles and thus form a rather heterogeneous sample. Fig. 2 provides an overview of the occupations represented in this survey. Not every occupation is represented in each of the four airport employee samples, which is likely to be due to the contacts we had and the distribution channels that were made available to us. Based on Pearson residuals, among the ground handling employees—the majority of which were in the Taipei and Singapore samples—there was a relatively high count of employees from the age bracket 25–34 (Pearson residual = 3.26), among passenger handling employees there was a relatively high count of 18–24 year-olds (Pearson residual = 4.24), and among security employees—who were mainly from Zurich—there was a relatively high count of 55–64 year-old respondents (Pearson residual = 4.11), as well as a relatively low count of 25–34 year-olds (Pearson residual = −3.5). The gender of customs/immigration officer respondents was skewed towards the male, while the passenger handling employee gender was skewed towards female.

The findings are presented in sections 3.2-3.5, following the objectives presented in the introduction (section 1). The bulk of the analysis involves 8 survey questions with 18 individual scales as presented in Table 2.

3.2. Communication and preparedness

It has been suggested that trust in information sources, awareness of the situation, and public perception of risk affect the adoption of protective behaviour during the pandemic (Lim et al., 2021). The following questions from our survey were aimed at understanding the communication channels used, quality of information, and employees' perceived preparedness for these measures and new procedures.

1. "How were you prepared for special measures/new procedures due to COVID-19?"
2. "How would you rate the information about measures/the pandemic situation provided at your workplace? A) Consistency, B) Timeliness, and C) Usefulness of information"
3. "How prepared do you feel for these measures/procedures?"
4. "How would you rate the appropriateness of implemented measures at your workplace?"

A variety of communication channels were used to prepare employees for special COVID-19 related measures/new procedures (see Fig. 3): the main channels were email and bulletin board/staff intranet. Other common channels were staff briefings, especially in Singapore, whereas respondents from Amsterdam indicated newsletters as common. It is also noteworthy that the informal 'word of mouth' was among the five most common channels. Only 13 respondents claimed that they were not prepared at all, suggesting they were either not notified about new procedures in any way or did not register any communication about these measures.

Subsequently, respondents were asked about the quality of information that was provided regarding special measures/new procedures. The question "How would you rate the information about measures/the pandemic situation provided at your workplace?" was used to assess whether the information was 1. Consistent, 2. Timely, and 3. Useful. The responses were collected on a 5-point scale ranging from "1 = Poor" to "5 = Excellent". More than 50% of the responses rated consistency, timeliness, as well as usefulness as "Good" or "Excellent." Cronbach's alpha was used to test the reliability and internal consistency of these three scales. The resulting value of $\alpha = 0.93$ indicates that these items are highly correlated, capture the same underlying concept, and are therefore an appropriate measure for the quality of information.

Respondents were also asked separately to rate how prepared they felt for the special measures/new procedures due to COVID-19 on a 5-point Likert scale (very unprepared, unprepared, neutral, prepared, and very prepared). In the next step, the relationship between the perceived quality of information as a latent variable—comprising information consistency, information timeliness, and information usefulness—and preparedness for COVID-19 measures/procedures was investigated through a simple structural equation model (SEM), shown in Fig. 4. The hypothesis that the quality of information directly and positively influences the feeling of preparedness for measures/procedures was confirmed. It was identified that quality of information explains 65% of the variance in preparedness for measures/procedures, which is considered satisfactory (Hair 2019). All estimates for the measurement model and the structural model were found to be significant at 95% confidence level ($p < 0.001$).

The first open-ended question, "What are things that you would have liked to make your job/work more comfortable and productive during the pandemic?", also yielded some answers relating to information and communication. The need for more information or better communication was not prominently featured. Only 6 respondents referred to it, requesting information about confirmed cases of COVID-19, among passengers/flights and coworkers (2 from Amsterdam, 1 from Taipei; 170:3, 439:3, 450:2), better information about support programs and improved communication (1 from Zurich; 551:1), as well as better communication with passengers regarding processes and measures (1 from Taipei, 1 from Amsterdam; 4:2, 383:2). One employee from Amsterdam wrote: "Covid19 (sic) context at airport changing continually – instituted policies & procedures require regular revision – for example AAS health declaration for departing flights no longer

Table 1
Sample characteristics.

	Total (n = 1017)		AMS (n = 265)		SIN (n = 225)		TPE (n = 302)		ZRH (n = 208)	
	freq	pct (%)	freq	pct (%)	freq	pct (%)	freq	pct (%)	freq	pct (%)
Gender										
Female	510	50.1	140	52.8	97	43.1	161	53.3	103	49.5
Male	503	49.5	123	46.4	128	56.9	139	46.0	105	50.5
Other	4	0.4	2	0.8	0	0.0	2	0.7	0	0.0
Age										
18 to 24	46	4.5	13	4.9	19	8.4	9	3.0	5	2.4
25 to 34	276	27.1	56	21.1	63	28.0	120	39.7	35	16.8
35 to 44	239	23.5	53	20.0	42	18.7	90	29.8	50	24.0
45 to 54	272	26.7	80	30.2	54	24.0	69	22.8	64	30.8
≥55	179	17.6	61	23.0	45	20.0	14	4.6	53	25.5
Prefer not to say	5	0.5	2	0.8	2	0.9	0	0.0	1	0.5

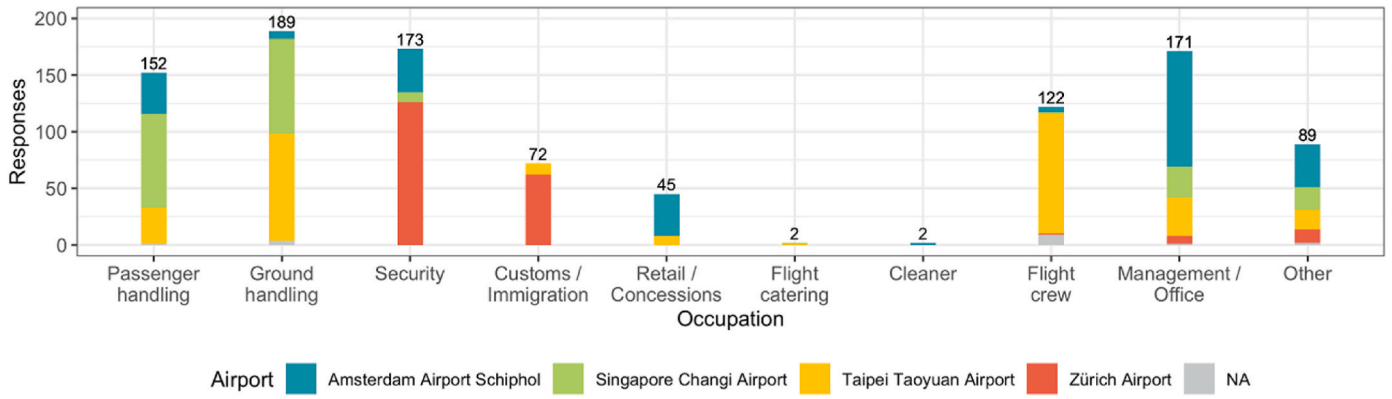

Fig. 2. Overview of participants' occupations at different airports (n = 1017).

necessary for most airlines as most are doing this on their own accord. Good communication with airport users is more important than ever to maximize safety & efficiency." (383:2).

As shown in Fig. 5, the majority of the employees at Schiphol, Changi, and Taoyuan airports felt prepared or very prepared for special measures/new procedures, while Zurich Airport employees felt significantly less prepared ($p < 0.001$).

3.3. Confidence in measures

Since the emergence of COVID-19, several precautions have been recommended by the World Health Organization to curb the spread of the virus (WHO). Employees were asked to indicate which measures were implemented at their workplace (Fig. 6) and how appropriate in general they think these implemented measures were (Fig. 7). Singapore Changi Airport received the highest ratings for appropriateness, while the two European airports in the study, Amsterdam Airport Schiphol and Zurich Airport, had the highest share of respondents who perceived the implemented measures to be somewhat too little or much too little.

We hypothesized that the perceived appropriateness of the implemented measures at the workplace influenced the concern of employees about contracting the virus from their co-workers or other passengers/customers. An ordinal logistic regression model was constructed to investigate such an association. The results are summarised in Table 3. The estimated values are in units of ordered log odds and somewhat difficult to interpret. Therefore, the estimated values were exponentiated to be converted into proportional odds ratios. It was concluded that for every one unit increase in the employees' perceived level of appropriateness of implemented measures at the workplace, the odds of being more concerned (i.e., fairly unconcerned, neutral, somewhat concerned, and very concerned versus not at all concerned) about contracting COVID-19 virus decreases by 49% [i.e., (1–0.507) x 100].

People's actual adoption of recommended protective behaviour has varied (see e.g. Munzert et al., 2021; Lim et al., 2021). We hypothesized that this is because of their confidence, or lack thereof, in the different measures. We therefore asked respondents of this survey about their confidence in five discrete measures to fight the spread of COVID-19: 1. Frequent hand washing/disinfecting, 2. Wearing masks, 3. Safe distancing, 4. Temperature screenings/checks, and 5. Use of contact tracing apps. Fig. 8 shows the mean and standard deviation of ratings given to each measure, from 1 representing "Not at all confident" to 5 representing "Very confident". Overall, 87% and 75% of the respondents were very confident or somewhat confident that frequent hand washing and wearing masks are effective measures, respectively, to fight spread of COVID-19. It should be noted that not all these measures were observed at all four airports. For instance, temperature screening was only practiced at Changi Airport and Taoyuan Airport, while wearing masks at work was mandatory at all airports.

Comparison of the measures within each airport showed that employees at Schiphol Airport and Zurich Airport were significantly more confident in frequent hand washing and safe distancing ($p < 0.001$), as compared to other measures. Employees at Changi airport and Taoyuan Airport were significantly more confident in frequent hand washing and wearing masks ($p < 0.001$), as compared to other measures.

Comparison of each individual measure to fight spread of COVID-19 between countries yielded some significant differences. Employees at Schiphol Airport and Zurich Airport trusted more in safe distancing ($p < 0.001$). At Schiphol, specifically, employees were found to be least confident about wearing masks ($p < 0.01$). Employees at Changi exhibited the highest ratings for temperature checks ($p < 0.01$) and contact tracing ($p < 0.001$). Confidence in washing and sanitizing hands was high in participating employees from all four airports and no significant difference between the airports was found at the 0.001 probability level.

3.4. Challenges, wants, and needs

3.4.1. Challenges

Participants were asked about the challenges at work during the pandemic. The challenges were introduced in three dimensions: 1. Keeping a safe distance, 2. Financial implications (e.g., pay cuts), and 3. Working from home. Financial implications were found to be the most challenging, followed by keeping a safe distance. Singapore Changi employees perceived financial implications as a significantly greater challenge than the other countries ($p < 0.001$) while employees from Zurich regarded this as the least challenging among the surveyed airports ($p < 0.001$). Zurich Airport employees also found keeping a safe distance significantly less challenging than those from other airports ($p < 0.001$), while no significant differences were found for the comparison among the other countries. In total, 263 employees (25.9% of respondents) replied "N/A" to the work from home challenge, indicating that work from home has not been an option for them.

The question about challenges also offered a write-in option, i.e., the first open-ended question. The thematic analysis can be drawn upon to gain insights into which themes the participating employees appear to emphasize (see Fig. 1 for an overview of the themes). Over half of the 99 responses to the question belonged to the themes *Workload/Hours/Flexibility* (29.2%) and *Job Security/Salary* (24.2%). Answers related to *Workload/Hours/Flexibility* identified challenges such as "little flexibility regarding work hours" (531:1), "increased workload" (592:1), or "no slots to work" (45:1—a part-time employee who was unable to be rostered for shifts). It is worth noting that both too big and too little a workload, are among the answers. Responses related to *Job Security/Salary* include comments such as "uncertainty about job/running projects" (291:1), and "layoffs" (10:1, 182:1, 235:1, etc.) among others. With 14.1% of write-in answers, *Policy Response,* was the third most

Table 2
Scale question summary.

	Scale point 1		Scale point 2		Scale point 3		Scale point 4		Scale point 5		M	SD	N
	freq	pct (%)	freq	pct (%)	freq	pct (%)	freq	pct (%)	freq	pct (%)			
How would you rate the information about measures the pandemic situation provided at your workplace?	*Poor*		*Below average*		*Average*		*Good*		*Excellent*				
1. Consistency	41	4.0	94	9.2	349	34.3	453	44.5	80	7.9	3.43	0.91	1017
2. Timeliness	54	5.3	114	11.2	345	33.9	438	43.1	66	6.5	3.34	0.95	1017
3. Usefulness	37	3.6	83	8.2	356	35	472	46.4	69	6.8	3.45	0.87	1017
	Very unprepared		*Unprepared*		*Neutral*		*Prepared*		*Very Prepared*				
Please rate how prepared you feel for the measures/procedures.	38	3.7	116	11.4	272	26.7	486	47.8	105	10.3	3.50	0.95	1017
	Much too little		*Somewhat too little*		*Appropriate*		*Slightly too much*		*Far too much*				
How would you rate the appropriateness of implemented measures at your workplace?	56	5.5	171	16.8	678	66.7	96	9.4	16	1.6	2.85	0.72	1017
How concerned are you about contracting the virus from	*Not at all concerned*		*Fairly unconcerned*		*Neutral*		*Somewhat concerned*		*Very concerned*				
1. Co-workers?	71	7.0	203	20.0	315	31.0	294	28.9	133	13.1	3.21	1.12	1016
2. Passengers/customers?	79	7.8	130	12.8	212	20.8	387	38.1	209	20.6	3.51	1.18	1017
How confident are you that the following measures help fight the spread of COVID-19?	*Not at all confident*		*Not very confident*		*Neutral*		*Somewhat confident*		*Very confident*				
1. Safe distancing	24	2.4	84	8.3	238	23.4	354	34.8	317	31.2	3.84	1.03	1017
2. Wearing masks	36	3.5	73	7.2	150	14.7	449	44.1	309	30.4	3.91	1.02	1017
3. Temperature screenings/checks	73	7.2	147	14.5	268	26.4	371	36.5	158	15.5	3.39	1.13	1017
4. Frequent handwashing/disinfecting	4	0.4	20	2.0	103	10.1	406	39.9	484	47.6	4.32	0.77	1017
5. Use of contact tracing apps	70	6.9	122	12.0	326	32.1	344	33.8	155	15.2	3.39	1.10	1017
What are particular challenges at work for you personally during this time?	*Not at all challenging*		*Not very challenging*		*Neutral*		*Somewhat challenging*		*Very challenging*				
1. Keeping a safe distance	55	5.5	164	16.4	214	21.4	348	34.8	220	22.0	3.51	1.16	1001
2. Financial implications (e.g. pay cuts)	72	7.3	75	7.6	216	21.9	296	30.0	329	33.3	3.74	1.20	988
3. Working from home	71	9.5	118	15.8	281	37.6	167	22.3	111	14.8	3.17	1.15	748
How do you feel about your job security? Has COVID-19 changed your outlook on job security?	Not at all concerned		*Fairly unconcerned*		*Neutral*		*Somewhat concerned*		*Very concerned*				
1. Before COVID-19	394	38.7	268	26.4	179	17.6	99	9.7	77	7.6	2.21	1.26	1017
2. Amid the pandemic	63	6.2	106	10.4	144	14.2	363	35.7	341	33.5	3.80	1.19	1017
How would you rate the overall impact of COVID-19 on your job?	*Very minor*		*Minor*		*Moderate*		*Severe*		*Very severe*				
	17	1.7	31	3.0	151	14.8	322	31.7	496	48.8	4.23	0.93	1017

frequent theme, and largely featured comments about quarantine regulations. This was followed by *Rule Compliance Issues* with 13.1%. Challenges concerning the compliance with rules can result from the behaviour of other people, yielding responses such as "passengers don't follow the new rules" (213:1) or "people who do not wear masks" (623:1), as well as from the respondent personally taking issue with the rules, yielding responses like "wearing a mask is troublesome" (604:1). *Relationships at Work, Physical Workplace/Technology, and Social Life,* are themes that each passed the 10% mark (11.1%, 10.1%, and 10.1% respectively), while all other themes fell below 4%.

3.4.2. Wants and needs

The second open-ended question, "What are things that you would have liked to make your job/work more comfortable and productive?", offered insights into employees' wants and needs. This optional question was answered by 225 respondents (22.1%). The two most frequent themes were *Physical Workplace/Technology* and again *Workload/Hours/Flexibility,* present in 40.0% and 30.7% of answers respectively. Responses falling under *Physical Workplace/Technology* include specific requests, for example for employee toilets, personal workspaces, or laptops provided by the employer, as well as general calls for "Better (modern) digital infrastructure" (280:1), or a cleaner workplace. Much like the similarly coded answers from the question about challenges, responses presenting the *Workload/Hours/Flexibility* theme highlight a desire for more flexibility regarding hours and place of work, i.e., home or office, more rest time, or also more (meaningful) work: "As the airport is practically empty, either staying at home or a meaningful assignment elsewhere" (568:1). The third most prominent theme was *Protective Equipment/Tests* fitting 24.9% of responses, including calls for specific items such as protective screens, general testing for the workforce, or

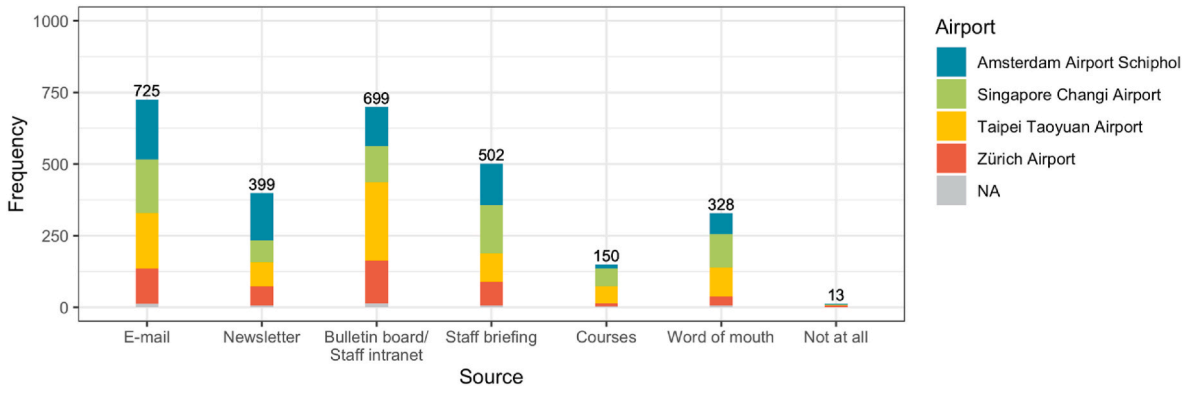

Fig. 3. How employees were prepared for special measures/new procedures due to COVID-19.

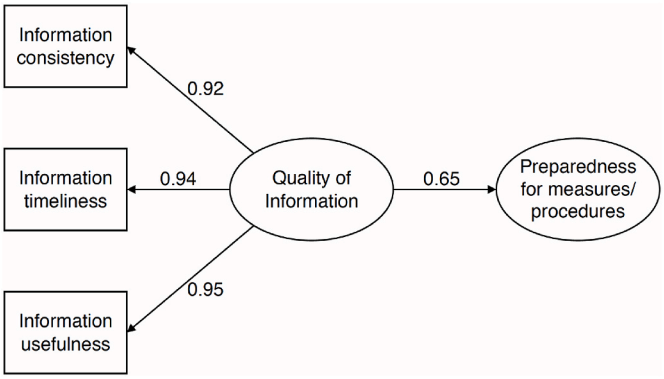

Fig. 4. Results of testing the hypothetical SEM model of the influence of the quality of information on COVID-19 and the perceived preparedness for COVID-19 measures and procedures.

comments about the quality of equipment, i.e., masks, gloves, gowns, they were given. *Relationships at Work* followed was the fourth most prominent theme with 16.9% of responses, stressing a perceived need for more teamwork, or more understanding and support from superiors. *Rule Compliance Issues* and *Policy Response* are the next most frequent themes, covering 12.9% and 12.4% respectively. Among *Policy Response,* comments relate to the response speed and the adoption of international recommendations. One employee pointed out they would have liked their airport to follow "WHO and other scientific advice to immediately implement mask usage requirements and additional sanitation. [The airport] took months to get it together!" (367:3) Another 20 responses, 8.9%, fell under *Passenger Contact. Job Security/Salary* was the last noteworthy theme with 4.9%, while all remaining themes were present in less than 1% of responses.

Respondents were also asked whether they would prefer more automated/non-touch support tools for their work. Depending on the profession, this could mean anything from existing self-service kiosks or automatic doors to completely new technologies. Rather than specifying a number of examples in the survey, the question was kept general in order to capture an overall desire for automation. 60.1% responded with yes, while 19.6% responded with no, and 20.4% were unsure. The respondents who selected yes represent 79% of flight crew, 78% of ground handling personnel, and 67% of passenger handling personnel in the sample, making these the professions most in favour of automated/non-touch tools. By comparison, the employee groups least in favour of more automated/non-touch tools were retail/concessions employees (38%) and customs/immigration (36%). The preference was observed equally among age groups.

3.5. *Impact, job security, and outlook*

The outbreak of COVID-19 negatively impacted economies and employment. Therefore, some questions were designed to allow the overall impact of COVID-19 on respondents' jobs and their job security to be quantified. In total, 80% of the respondents perceived the impact of COVID-19 on their jobs as severe or very severe, on a 5-point scale. Perceived job security was split into two items: before and after the pandemic. Fig. 9 shows how the perceived job security of airport employees has considerably dropped after the pandemic. A major increase of more than 50% is observed in the number of severe and very severe responses about job security.

Respondents were asked to rate how they perceived the overall impact of COVID-19 on their jobs on a 5-point Likert scale (very severe, severe, moderate, minor, and very minor). An ordinal logistic regression model was constructed to evaluate this perceived overall impact of COVID-19 on airport employees' jobs—regardless of its nature—considering employees' location, age group, and gender. Table 4 summarizes the results of this model.

Employees from Amsterdam and Taipei felt significantly more

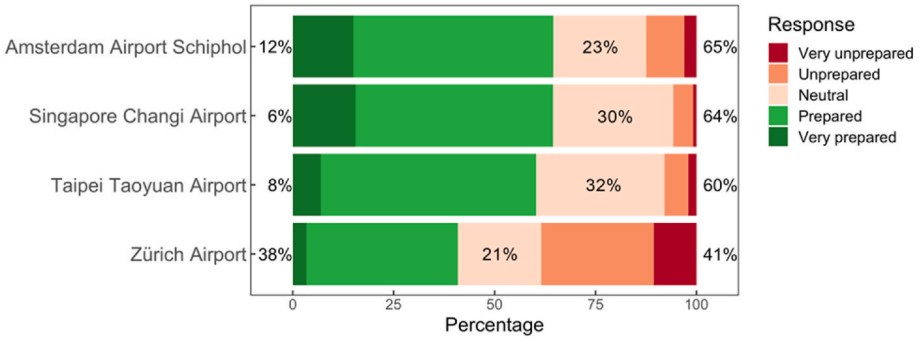

Fig. 5. Feeling of preparedness of respondents by airport.

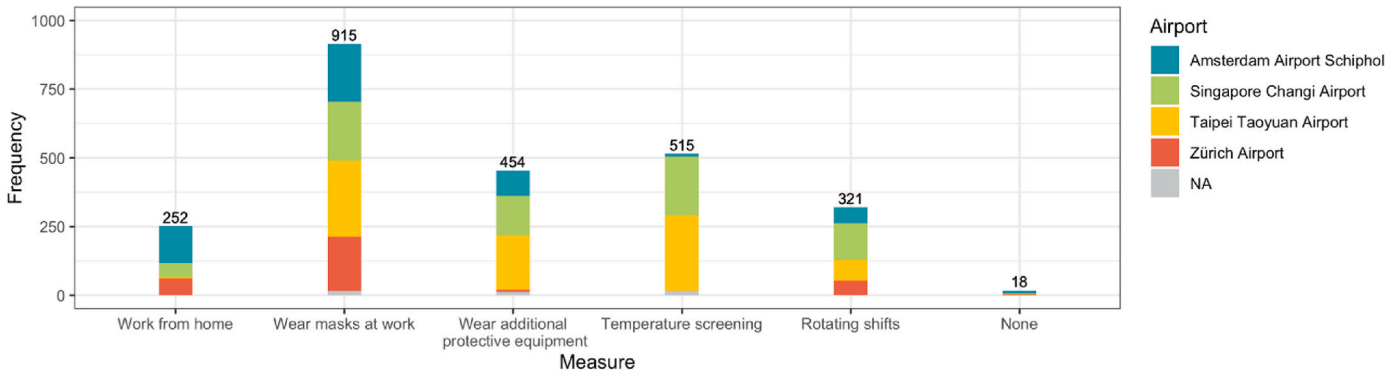

Fig. 6. Measures taken at place of work when the pandemic broke out.

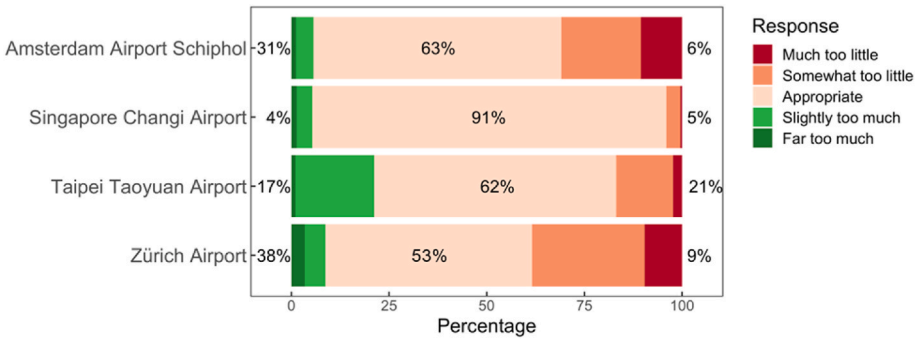

Fig. 7. Perceived appropriateness of measures at the surveyed airports.

Table 3
Association between employees' concern of contracting COVID-19 virus and appropriateness of implemented measures at workplace.

	Value	Std. Error	*t*-value	*p*-value	OR [95% CI]
Appropriateness of implemented COVID-19 measures at workplace	−0.68	0.08	−8.02	0.000	0.51 [0.43–0.60]
Intercepts:					
Not at all concerned | Fairly unconcerned	−5.10	0.30	−16.96	0.000	0.01 [0.00, 0.01]
Fairly unconcerned | Neutral	−3.79	0.27	−14.13	0.000	0.02 [0.01, 0.04]
Neutral | Somewhat concerned	−2.56	0.25	−10.04	0.000	0.08 [0.05, 0.13]
Somewhat concerned | Very concerned	−0.72	0.24	−2.97	0.003	0.49 [0.30, 0.78]

Residual deviance: 2737.28.
AIC: 2747.28.
OR: odds ratio.
[95% CI]: lower and upper bound of 95% confidence interval.

impacted by COVID-19 compared to Singapore and Zurich. Female employees also indicated higher impact ratings as compared to men having a 0.4 unit increase in the odds of impact. The age group 25–34 felt the most significantly impacted by COVID-19, as compared to any other group, while the age group 35–44 felt the least impacted.

Participants of the survey were also asked to express their outlook on the recovery from COVID-19. Their answers ranged from "Very pessimistic" to "Very optimistic" on a 5-point Likert scale. Employees at Changi Airport were found to be significantly more optimistic about the recovery from COVID-19 ($p < 0.001$, mean rating = 3.3, standard deviation = 1.0). Swiss respondents were the least optimistic in this study.

The qualitative analysis revealed that, with almost 85% (n = 11) the majority of responses coded "news media" were from Swiss respondents, pointing out their personal challenges as, for example, "general hysteria/media coverage" (611:1), or revealing their personal coping strategies as restricting their news media diet.

The third open-ended question, "Do you have any personal coping techniques/strategies for the current pandemic situation?", revealed further insights into employees' outlook and means of dealing with the problems and uncertainty brought on by the pandemic. This optional question was answered by 202 respondents (19.9%). *Personal Responsibility* was by far the most prominent theme, covering 40.6% of responses. Most responses within this theme were some variations of "keep distance, wash hands, wear mask" (351:2), while some respondents gave more elaborate answers such as "avoiding contacts; keeping my hands in my pockets and not touching anything when using public transportation; avoiding activities in tight spaces" (522:3). *Mental Wellbeing* and *Physical Wellbeing* are the second and third most prominent themes with 24.8% and 22.8% respectively, with close to half of respondents commenting on mindfulness, positivity, spirituality, and exercise and outdoor activities. Previous research by Manoharan et al. (2021) has already linked spirituality to career optimism in hotel workers. Some respondents gave rather detailed descriptions: "A lot of cycling or walking makes staying home more bearable. Then you can cook nice food for yourself and create that eating out feeling at home" (849:2). The theme *Media Consumption* was present in 10.4% of responses, covering both active consumption of media such as streaming services and books, but also the previously mentioned avoidance of consuming news media to reduce stress. *Protective Equipment/Tests* and *Rule Compliance Issues* fit about 5% of responses (5.4%, 5% respectively), with respondents noting the use of personal disinfectant, carrying of additional masks, and reminding others to wear their masks properly or keep a distance, as their coping strategies. The remaining themes were all present in under 2% of responses.

Fig. 8. Respondents' confidence in different measures to fight the spread of COVID-19, 1 = not at all confident, 2 = not very confident, 3 = neutral, 4 = somewhat confident, 5 = very confident.

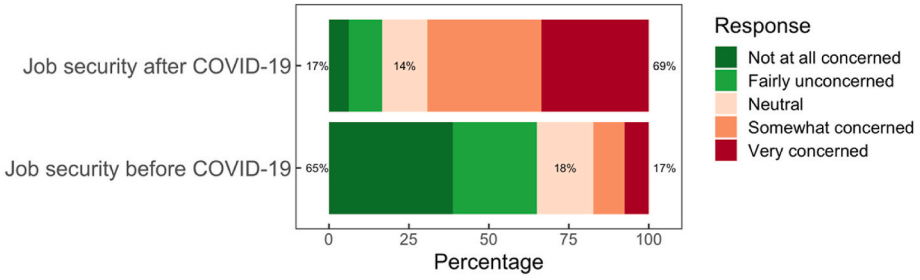

Fig. 9. Perceived job security before and after the pandemic.

4. Discussion

4.1. General discussion

The results from the survey generally showed that, while there are commonalities among all airport employees—given the global nature of the pandemic—there are several regional differences in perceptions. This can occur within the larger regional context, i.e., Asian airports vs. European airports, as evidenced by "confidence in measures" or "appropriateness of measures", but also at the country level, as evidenced by responses from Zürich for "feeling of preparedness", differing significantly from the rest of the airports (despite no significant difference in preparation channels) or respondents from Singapore Changi Airport being significantly more optimistic than the rest. The study thus highlights that even though many of the measures and implications surrounding the pandemic are the same—or at the very least conceptually similar—all over the world (e.g. mask mandates, distancing regulations, travel restrictions and quarantine, job losses, retrenchments, economic impacts, and so forth), the distinct local differences have a significant bearing on the respondents' perceptions of and experiences with the pandemic situation. These differences may be cultural—the public's attitude towards measures and restrictions, political—the mandatory or recommended nature of the measures, their duration, and relief packages, or—as responses from Zürich seem to suggest—related to the local media narrative. Regardless of their nature they have a major impact on the respondents' perceptions of and experiences with the pandemic situation. This mirrors the general global pandemic situation, wherein the challenges and responses were similar worldwide, but cultural, political, or media-related differences, among others, shaped local perceptions (see e.g. Zhang 2021; Georgieva et al., 2021). As such, it highlights the unique positioning of international airports as the nodes of cross-border connectivity, interfacing with the pandemic and its consequences at the most global level, while still being fundamentally rooted in their national and regional contexts—their workforces being affected primarily by local response mechanisms and narratives. Moreover, the waves of the pandemic have hit different countries at different times and restrictions and countermeasures are imposed relative to these developments. In some cases, as mentioned regarding temperature screenings at European airports, certain measures were not taken in all countries and local restrictions also varied widely.

A reassuring finding, the confidence in hand washing/disinfecting was generally high among all respondents, regardless of the airport they

Table 4
Overall impact of COVID-19 on employees' jobs.

	Value	Std. Error	*t*-value	*p*-value	OR [95% CI]
Airport					
AMS	–	–	–	–	–
SIN	−0.59	0.13	−4.70	0.000	0.55 [0.43–0.71]
TPE	−0.07	0.13	−0.57	0.570	0.93 [0.73–1.19]
ZRH	−0.50	0.12	−4.14	0.000	0.60 [0.48–0.77]
Gender					
Male	–	–	–	–	–
Female	0.40	0.09	4.53	0.000	1.49 [1.25–1.77]
Age group					
18–24	–	–	–	–	–
25–34	0.65	0.21	3.07	0.002	1.92 [1.27–2.92]
35–44	−0.51	0.19	−2.68	0.007	0.60 [0.41–0.87]
45–54	0.00	0.15	0.03	0.975	1.00 [0.76–1.33]
≥55	0.05	0.13	0.38	0.705	1.05 [0.82–1.34]
Intercepts:					
Very minor | Minor	−4.01	0.25	−16.14	0.000	0.02 [0.01–0.03]
Minor | Moderate	−2.94	0.15	−18.99	0.000	0.05 [0.04–0.07]
Moderate | Severe	−1.32	0.09	−14.27	0.000	0.27 [0.22–0.32]
Severe | Very severe	0.23	0.08	2.82	0.005	1.26 [1.07–1.47]

Residual deviance: 2252.30.
AIC: 2276.30.
OR: odds ratio.
[95% CI]: lower and upper bound of 95% confidence interval.

are employed at. Safe distancing, especially in the European context, and mask wearing, especially in the Asian context were also rated with relatively high confidence. Although respondents from Singapore in particular were rather confident in contact tracing (likely related to the national contact tracing program in the country), the general trend appears to be that employees are more confident in measures that give them some degree of control over their execution. Especially hand washing/disinfecting, the measure with the highest ratings, is largely in the hands (literally) of the individual and offers its promised protection even if others do not wash or sanitize their hands. This importance of control and autonomy is also reflected in the write-in answers, particularly for the question concerning personal coping strategies, as most answers fell into the theme *Personal Responsibility*. The majority of respondents who answered this question therefore cope by enacting the measures they have control over, namely hand washing, mask wearing, and distancing.

The study also highlighted the vulnerability of airport employees as a workforce highly affected by the economic impacts of the pandemic; the theme *Job Security/Salary* was pointed out as a major challenge for write-in answers and financial implications was the most highly ranked pre-defined challenge. The employee experience, as the difference between expectation and reality (see Tuchen et al. 2020), reflects the sudden precarity of employment within airports as organizational ecosystems. Perceived job security was virtually turned upside down in the comparison of *before* and *after* COVID-19. As such, a majority of participants were not aware of their inherent vulnerability to major events like pandemics.

While our examination of the outlook and thereby long-term optimism of respondents showed clear differences in countries (and local media narratives), the responses on perceived severity of the impact highlights a further important dimension of the employee experience: age. The age bracket that felt most impacted, 25–34 years, had a significantly higher number of ground handling employees and a significantly lower number of security employees compared to other age groups. This makeup may play a role in the perceived impact of this age group, however, it is also likely that the group's unique position along the career trajectory has an effect on the perceived high impact. For those aged 18–24 years, job/career changes are still a viable option. The 25-34 year-olds, on the other hand, are not as fresh to full-time employment, arguably having settled in more into their roles, while the bulk of their careers are still ahead of them. Establishing themselves in careers that might seem "doomed" (especially at the time of survey taking in late 2020) given the uncertainty, could be a possible explanation for their perceived severity of the pandemic impact. The age group that perceived the least impact, 35–44 years, did not represent any significantly higher or lower numbers of professions. Although similar reasons for the perception could apply to this group, they are the only one with a significantly lower perceived impact. More research may need to be done on the reasons behind employee perceptions on the impact of the pandemic, as well as on the consequences for their motivation.

4.2. Practical implications

In the broadest sense, the airport employee perceptions presented in this paper warrant action to protect the workforce both in terms of job security, as well as with regard to the COVID-19 pandemic and future disease outbreaks. The workforce at airports, like employees in tourism and hospitality (see also Manoharan et al., 2021), is vulnerable to the economic impacts of the pandemic and due to the frontline nature of many jobs also to contact with disease carriers. As mentioned, the pandemic had a major impact on perceived job security. On the topic of protection from the virus, *Protective Equipment/Tests* was a prominent theme relating to employees' wants and needs, highlighting both the importance of protection in and of itself but also, via codes within the theme, the quality of the equipment supplied. Along these lines, avenues present themselves for employers and other stakeholders to take action at two distinct levels.

1) Immediate short-term actions that can be taken now or at any point throughout the recovery (or potentially again during other disease outbreaks or crises)
2) Long-term changes to organizational practices—as lessons learned from the pandemic—to create more flexible, adaptable and resilient structures to weather future shocks and the VUCA environment at large.

Immediate steps can directly link to feedback from employees as seen under the *Protective Equipment/Tests* theme from the qualitative analysis. Good communication with the workforce at the frontlines can provide instant insights into which supplies—and measures—work well, which ones do not, and what else might be needed. Proper physical protection of employees may seem like an obvious step, however, the responses from this survey show that the implemented solutions are not entirely satisfactory. Good communication from employer to employee, was also pointed out as positively impacting the work experience. While differences in preparedness were observed, it was shown that good quality information (timely, consistent, useful) can make a positive contribution to the feeling of preparedness. Some responses from the optional questions suggested that real time information about COVID-19 cases (among the workforce and aboard flights) should be provided. Other

employees pointed towards providing more information for passengers. Considering the front-line nature of many airport employees' work, clear information for passengers ahead of the airport usage would likely make the employees' job easier and predictable.

In a document outlining recommendations for health systems, the WHO mentions both the physical health, as well as the mental health of employees (World Health Organization, 2020). As pointed out earlier, the surveyed employees are willing to and do take initiative. Employers could foster this and offer their support as a near-term measure for the recovery from and aftermath of COVID-19. Corporate social responsibility (CSR) programs, when targeted at the workforce, have been argued to be beneficial to self-efficacy (Mao et al., 2020). As a component of the larger construct of psychological capital (Mao et al., 2020), self-efficacy can contribute toward employees taking the initiative presented in this study, while not burning out. "Individual-level psychological resources such as adaptability, resilience, and self-efficacy" have also been pointed out as important factors for career optimism, with managerial support (and personal social support networks) identified as particularly beneficial within this context (Manoharan et al., 2021). Naturally, short-term CSR actions could also evolve into general long-term support practices for the workforce. Furthermore, given the large number of companies working within the context of the airport, airport operators could step up to foster a support network across company boundaries.

A potential long-term solution to further resilience and mitigate the VUCA-induced problem of job security, could be concrete plans for retraining and flexible redeployment. Sobieralski (2020) points out that the economic impact is not evenly distributed among all airport employees. "The occupations related to passenger handling at major airlines are noted as a category that is hardest hit and could benefit most from a safety net such as career transition assistance" (ibid.). Sobieralski (2020) further points out that "lower skilled" employees—or less belittlingly, those in the low wage segment—are particularly affected by layoffs. As a stopgap solution, flight attendants from the Singapore Airlines Group were redeployed as care ambassadors in nursing homes and hospitals in Singapore (Ng 2020; *CNA* 2020), while personnel from various other companies at Changi Airport took on reassignments in logistics or e-commerce (Toh 2020). Although this temporary repurposing of the workforce is a commendable effort, long-term contingency plans for more flexible HRM practices may be worth exploring. When future major events like COVID-19 hit the industry, well-thought-out strategies can guide a quick reassignment from jobs that are no longer needed, to jobs that are seeing an increased labour demand. There is a clear advantage in these strategies over simply laying off the workforce: when the industry recovers, labour shortages, as seen in the recovery from COVID-19 (Tilo 2022; Eccles 2022; Power 2022), can be minimised. Inherent job insecurity is also not only an issue for employees who are directly affected by layoffs. The perceived precarity can lead to drops in productivity as well as "voluntary resignations by valuable employees who are insecure about their futures with the company (and the need to locate and hire replacements)" (Allan 1997). In the aftermath of COVID-19, "workforce transitions may be larger in scale than […] estimated before the pandemic, and the share of employment in low-wage job categories may decline." (Lund et al., 2021).

Ultimately, long-term contingency plans would also subsume a broader paradigm shift in seeing airport operations as having any form of normal. Authors such as Wales et al. (2002), Knox et al., (2008), and O'Doherty (2017) have repeatedly described airport organizations in ways that would suggest the general concept of "normal" operations are but an illusion. These authors have pointed out that, apart from future planning, uncertainty also exists in daily operations. Addressing the VUCA elements, would mean shifting the focus away from a preconceived notion of normalcy to create more adaptability and flexibility for the sake of organizational resilience. Finally, as airports are complex employment ecosystems, the transformation has to occur across stakeholder boundaries and requires an alignment of strategic goals that has previously not been given (see e.g.van der Zwan, Santema, and Curran, 2009). The pandemic has forced a rethinking of work that may "accelerate many of the future of work imperatives that were already clear before COVID-19." (Lund et al., 2021).

4.3. Limitations

While the diverse range of respondents was beneficial regarding the exploratory intentions behind this research, more equality among the different professions would have allowed more comparisons on an occupation-by-occupation, as well as country-by-country, basis. Several factors assessed based on the airport the respondents work at, such as "confidence in measures" were deemed unlikely to be significantly influenced by the specifics of the job and therefore shed light on the influence of the local COVID-19 situation and related cultural differences on the confidence in implemented measures to fight the spread of the virus. Additionally, as the distribution of occupations among respondents was not equal, there are insights in the data, particularly the qualitative portion, that may not appear significant on mere numeric terms but could prove worthy of further study.

Due to the challenging nature of accessing employees at airports, it was not possible to employ probability sampling; the participating companies did not provide the demographic information about their employees necessary to build a sample frame (see e.g. Galloway 2005). Since the researchers depended on companies to internally distribute the survey and, in the case of Taiwan, an online forum, determining the actual response rate is not possible as the sample population size—the number of employees reached with the survey—is unknown. Because of the complexity underpinning the distribution and sampling, we cannot rule out the presence of self-selection bias in the responses. Respondents facing issues, e.g., may have been more likely to take the survey (Lavrakas 2008) as opposed to their colleagues. However, as an important object of the study was largely to identify issues that airport employees face during the pandemic, as well as the nature thereof, the findings ultimately do not lose any of their value. The authors do not claim to provide a representative picture of all airport employees, but instead work within the limitations of the sample to provide insights. Overall, however, given that the population size was unknown, the sample size of 1017 exceeds the 384 responses necessary to stay within a 5% margin of error at a 95% confidence level, according to the Cochran formula for the estimation of sample sizes with unknown populations (Cochran 1977).

4.4. Future research

The analysis of challenges has revealed several areas of importance for employees that could be studied in greater detail. As responses to the question "What are things that you would have liked to make your job/work more comfortable and productive?" indicated, the physical workplace appears to play an important role in how comfortably airport employees can perform their tasks. The survey itself did not include specific questions regarding the physical workplace, apart from two questions about the habits concerning the use of amenities. It could therefore be worthwhile to include more questions about the specific workstations, adequacy of break rooms, IT infrastructure, cleanliness at the workplace, automation, among others, and evaluate the impact these factors have on satisfaction and/or productivity. Likewise, flexibility and workload were not explicitly mentioned in the survey and could be assessed in future iterations, even beyond the pandemic. The issue of local influences (cultural, political, etc.) could also be expanded on in future studies. Aside from keeping track of the specific local contexts via news media, press releases, etc., data could also be collected within future surveys themselves. Restrictions at the time of survey taking, communication beyond the workplace, trust in local institutions, etc. are all potentially interesting variables that could be compared among the different study sites and related to other survey items.

Given the exploratory nature of the study, overall, more data and points of interest were explored than could fit the scope of one paper. One such example—that also was not highlighted given the small number of employees from the profession within the sample—is the experience of employees who deal with passengers with disabilities. Three passenger handling employees who work with passengers with disabilities all mentioned the same issues in their responses, namely that within their role, distancing is not possible. One of them phrased it as such: "[…] The distancing and hygienic rules are clear. But within my position as an assistant everything goes against the rules. 1. Each task takes 15 min to an hour. 2. No 1.5 m distance possible. 3. These vulnerable people are not obligated to have extra tests [or] checks and most of their trips are not necessary […]." (453:3) While these employees were eclipsed by others who took the survey in larger numbers, there individual perceptions are no less valid or valuable and a more detailed look at those who work with as well as the passengers with disabilities themselves, could yield important insights into how their experiences are intertwined.

Despite the practical challenges that arise from dependence on airport stakeholders for access to employees, it would also be advisable to align the sample sizes of the occupations at the airports being surveyed. Repeating the study would also allow insights into changes in perception as the recovery progresses.

5. Conclusion

Being among the forgotten front-line employees (FLEs), employees at the world's international airports had to face both health risks associated with working at gateways into their respective countries, as well as the economic risks resulting from the impact the pandemic has had on civil aviation. This study has highlighted the experience and perception of employees at four major international airports (and their employment ecosystems) and provided insights into issues that are important to them. While the local situation in the country of residence affects issues such as the confidence in measures and the outlook and optimism, other issues, such as the impact on perceived job security are global. We have derived several avenues for industry action and future research from the responses the surveyed employees provided. "The pandemic will eventually fade, but the agility and creativity of policy makers and businesses evident during the crisis will need to continue, to find effective responses to the looming workforce challenges." (Lund et al., 2021).

CRediT authorship contribution statement

Stefan Tuchen: Conceptualization; Data curation, Formal analysis, Investigation, Methodology, Project administration, Validatio, Visualization, Writing - original draft, Writing - review & editing. **Mohsen Nazemi:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing - original draft, Writing - review & editing. **Signe Maria Ghelfi-Waechter:** Conceptualization, Data curation, Investigation, Methodology, Validation, Writing - review & editing. **Euiyoung Kim:** Conceptualization, Data curation, Investigation, Methodology, Validation, Writing - review & editing. **Franziska Hofer:** Conceptualization, Data curation, Investigation, Methodology, Validation, Writing - review & editing. **Ching-Fu Chen:** Conceptualization, Data curation, Investigation, Methodology, Validation, Writing - review & editing. **Mohit Arora:** Conceptualization, Methodology, Writing - review & editing. **Sicco Santema:** Supervision, Conceptualization, Validation, Writing - review & editing. **Lucienne Blessing:** Supervision, Funding acquisition, Conceptualization, Validation, Writing - review & editing.

Data availability

Data will be made available on request.

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