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Segmentation of passenger preferences for using digital technologies at airports in Norway

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ABSTRACT

Airports are increasingly focused on implementing digital technologies at key stages of the airport journey to enhance the passenger experience. However, passengers have different preferences. TwoStep Cluster Analysis is used to reveal the presence of distinct segments according to their preferences. The findings are based on a survey of 6082 passengers at airports in Norway. Three distinct segments are identified: those that prefer traditional manual processes, those that prefer automated technology-based processes, and those that prefer more personalised technology-based processes. Significant differences are revealed for each segment according to passenger and trip characteristics and opinions regarding how the use of digital technologies at airports impact on personal privacy and human dignity. The findings contribute to knowledge on passenger preferences at airports and can help to inform airport decision making.

1. Introduction

The airport experience is of great interest to researchers (Jiang and Zhang, 2016; Wattanacharoensil, 2019; Wattanacharoensil et al., 2017). This is because it can be a driver of airport competitiveness by influencing expenditure in commercial areas (Chung, 2015; Lin and Chen, 2013; Lu, 2014), airport reuse (Hong et al., 2020; Nesset and Helgesen, 2014; Prentice and Kadan, 2019), and recommendation likelihood (Halpern and Mwesiumo, 2018; Nesset and Helgesen, 2014). It can also have wider implications by influencing destination image (Martín-Cejas, 2006; Wattanacharoensil et al., 2017) and re-visitation (Hong et al., 2020; Prentice and Kadan, 2019). However, the airport experience can be a stressful and frustrating ordeal for passengers who feel they are being 'bounced' from one touch-point to another by multiple different service providers (Halpern and Graham, 2013; Graham, 2018). These interactions can disrupt the passenger journey and be a source of great frustration due to inconsistent or inadequate levels of service quality (Halpern and Mwesiumo, 2018).

The passenger experience is therefore often at the forefront of the minds of airports when making investment decisions, and technological solutions are increasingly recognised for the role they can play in improving the passenger experience (Brida et al., 2016). In their survey of 115 managers at airports worldwide, Halpern et al. (2020) found that enhancing the passenger experience is the main driver for investing in digital technologies at airports (77% of respondents selected this from a list of 11 options). This is followed by enhancing safety and security (73%), generating additional revenue (44%) and reducing operating expenditure (44%). In addition, a study by the air transport communications and information technology firm SITA found that airports invested a record US$11.8 billion on technology in 2019 (up from US $7.0 billion in 2016) and had strong investment plans for emerging solutions in passenger-related areas. By 2022, 85% of airports planned to have invested in biometrics for identity management, 77% in interactive navigation, and 67% in artificial intelligence such as predictive analytics and virtual agents and chatbots (SITA, 2019a). The losses incurred at airports as a result of the COVID-19 pandemic are expected to have a significant impact on investment plans – most likely resulting in the postponement of several of them. However, technologies are also

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expected to play a key role in dealing with current or future health measures at airports. Biometrics, interactive navigation, and artificial intelligence offer contactless and touchless solutions and are therefore just as relevant in the post COVID-19 world as they were before it. Technologies are also expected to play a key role in helping to improve the financial health and viability of airports experiencing long-term reductions in traffic as a result of COVID-19.

In order to make the best possible investment decisions, it is important for airports to know and understand the preferences of their passengers. Previous studies have looked at preferences for individual technologies such as biometrics (del Rio et al., 2016; Morosan, 2016; 2018; Negri et al., 2019), self-service check-in (Bogicevic et al., 2017; Castillo-Manzano and López-Valpuesta, 2013; Gures et al., 2018; Lee et al., 2014; Lu et al., 2009; Taufik and Hanafiah, 2019; Wittmer, 2011), and information services (Brida et al., 2016) while several global surveys have investigated passenger preferences more generally (IATA, 2019; SITA, 2019b). Other studies have explored the impact of attitudes and opinions, for instance, Beck et al. (2018) investigate how concerns over safety, privacy and distrust affect passenger preferences for security screening procedures at airports. In addition, Airports Council International (ACI), the global airport trade body, define 'personas' based on prevailing passenger and trip characteristics for more targeted customer experience planning (ACI, 2016). However, there is a lack of research that seeks to segment passengers according to shared preferences, passenger and trip characteristics and opinions regarding the use of digital technologies at airports, which is the focus of this study.

Specifically, this study seeks to answer the following research questions (RQs): RQ1. What are the preferences of passengers at key stages of the airport journey? For instance, at check-in, security screening, and passport control. RQ2. What distinct segments of passengers can be identified regarding preferences at key stages of the airport journey? RQ3. How do segments vary according to passenger and trip characteristics and opinions about the use of digital technologies at airports? By addressing these questions that are further elaborated in the next section, this study partly responds to Morosan (2018) who calls for a greater knowledge and understanding of how convenience-driven behaviours manifest in contemporary air travel. The findings are based on a survey of 6082 departing passengers at airports in Norway. Descriptive analysis investigates passenger preferences at key stages of the airport journey (RQ1). A TwoStep Cluster Analysis is used to identify the presence of distinct segments according to those preferences (RQ2). Chi-square and analysis of variance (ANOVA) tests are used to compare segments according to their preferences, passenger and trip characteristics, and opinions about the use of digital technologies at airports (RQ3).

Section two of this paper provides background to the study with a focus on options available to passengers at key stages of the airport journey and on segmentation as a tool for identifying commonalities among passengers. Section two also provides background for the three research questions to be addressed. Section three describes the methodological approach taken in terms of survey design and data collection, key variables and data analysis. Section four presents results of the analysis and a discussion of the main findings. Section five provides a conclusion that highlights the main contributions and managerial implications, and several study limitations and recommendations for further research.

2. Background and research questions

In air transport research, the passenger journey is often described as a series of key stages. For instance in their global passenger survey, IATA (2019) break the passenger journey into ten key stages (booking, payment, check-in, bag tag, security, border control, boarding, in-flight entertainment, on-board service and bag collection), while in their passenger IT insights, SITA (2019b) break the passenger journey into nine key stages (booking, check-in, bag tag, bag drop, passport control, dwell time, boarding, on-board, and bag collection). Some of the stages are primarily associated with the airline experience (e.g. booking, in-flight entertainment and on-board service), while the others take place 'at airports'. In addition, some take place on arrival (e.g. bag collection), while others take place on departure.

This study focuses on key stages that take place at airports on departure. More specifically, it focuses on seven key stages: accessing a boarding pass and completing bag tag and bag drop processes at check-in, personal identification (ID), security screening, paying for products and services during dwell time, and accessing customer services. For the last few decades, new digital technologies have been implemented at these stages of the airport journey, in line with more general trends towards digitalisation at airports (Halpern et al., 2021a, 2021b; Kovynyov and Mikut, 2019; Zaharia and Pietreanu, 2018). For instance, check-in has traditionally been carried out by staff at a check-in desk. Increasingly, digitalisation has allowed passengers to conduct the process themselves (including to access their boarding pass), initially via self-service kiosks (Castillo-Manzano and López-Valpuesta, 2013; Wittmer, 2011), and more recently via their mobile device (Inversini, 2017). Similar progress has been made with bag tag and bag drop processes, which are also now widely conducted using self-service technologies. There is also growing interest in digital bag tag options. These potentially offer added value to passengers with features such as the ability to update the tag for each journey from a mobile device, track the baggage throughout its journey, automatically report mishandled or lost baggage, activate an alarm in case of theft, and send a notification when baggage is available for collection, and from which belt.

There are also growing efforts to move check-in (including bag tag and bag drop processes) away from the airport or terminal building, for instance, to airport car parks or downtown locations, or with the option for passengers to pay to have their baggage collected (e.g. from home) by a company that then transports it to the airport and checks it in for them. These solutions can help to reduce congestion and queueing times at airports and allow passengers to travel and arrive at the airport 'baggage free'.

In terms of personal ID, the need to show paper documents such as a boarding pass along with a passport or other ID to staff is increasingly replaced by digital options such as mobile-based boarding passes to scan at automated gates. Several airports are now experimenting with biometric authentication. This utilises unique identifiers related to a passengers' finger print, iris or facial features (del Rio et al., 2016; Farrell, 2016; Haas, 2004; Mears, 2017; Morosan, 2016; 2018; Negri et al., 2019), and has been applied at e-gates at passport control, as well as other stages of the airport journey including check-in, bag drop, security and the departure gate. By pre-registering ones biometric details before arriving at the airport, it is thought that passengers can enjoy a more seamless 'walking pace' experience than the current typical airport journey. Similarly, biometric and other advanced technologies such as infra-red cameras, are gaining interest for their ability to scan passengers as they walk through security without needing to remove items for screening.

On the retail and catering side (i.e. to purchase goods or food or drink during dwell time at the airport), new payment methods mean that in addition to cash, credit or debit card payments, airports are starting to offer mobile payment options, for instance via a mobile application that connects card payments to phone numbers or via an e-wallet.

Technology also plays a key role in passenger information and communication systems (Brida et al., 2016). On occasions when passengers need to access customer services, the traditional approach has been to deal with staff in person that might be located at an information desk, roaming the terminal or accessed via telephone. Now, at many airports passengers can expect to access customer service assistance via a video link or live online chat service, or via self-service technologies such as touchscreen information kiosks or QR codes that can be scanned using a mobile device to access further information. Some airports have introduced solutions that use augmented reality or artificial intelligence

including holograms, chatbots, and robots.

All of the aforementioned options are included in this study. There are of course other technologies that can be deployed by airports to improve the passenger experience that are not included in this study. For instance, prior to entering the airport terminal, passengers may use airport digital channels such as websites (Halpern and Regmi, 2013) or social media (Halpern, 2012; Wattanacharoensil and Schuckert, 2015) to access information or to pre-purchase airport products or services, or use self-driving robot valets to park their car at the terminal (e.g. introduced at Lyon-Saint-Exupéry Airport in 2019), while there may be autonomous and driverless shuttles (e.g. currently being trialled at Brussels Airport and Tokyo Haneda Airport) to transport passengers airside. There are also more futuristic options such as the use of body-embedded ID, drone-based baggage collection and delivery, ambient security scans on arrival at the airport, acceptance of virtual currencies (e.g. Bitcoin), and experimental centres (e.g. with 3D printed goods or food) (Halpern et al., 2021). However, this study focuses primarily on those that are currently used at airports in Norway (as well as in many other countries) or are currently under consideration. This still leaves airports with a wide range of potential solutions, and it is important that investment decisions are based on a thorough understanding of passenger preferences. The first research question (RQ1) therefore asks:

RQ1: What are the preferences of passengers at key stages of the airport journey?

Introducing technology-based alternatives to manual processes makes sense given that passengers have high levels of adoption for digital technologies, and increasingly demand and expect interactions with digital technology at various stages of their journey (IATA, 2019; SITA, 2019b). In addition, it has been shown that satisfaction with key airport processes is higher among passengers that use digital technologies than those who do not (Bogicevic et al., 2017; Brida et al., 2016; IATA, 2019; SITA, 2019b). Given the generally agreed consensus that satisfied passengers are likely to spend more money on retail and food and drink at the airport, the integration of digital technologies can have significant commercial benefits, as well as positive operational and service quality impacts for airports.

While many passengers are embracing technology, it is important that airports also consider the needs of passengers who are not familiar with, or interested in using, digital technologies. For instance, 17% of passengers at Brazilian airports would not use biometric technologies at check-in if given the choice (Negri et al., 2019). In addition, many countries have ageing societies that may be less familiar with airport automation and self-service technologies, and may require assistance at airports (Graham et al., 2019). It is important that the preferences and needs of these passengers are not overlooked. Segmentation is a valuable tool for accounting for these variations in passenger preferences, and can be used strategically to help prioritise investment decisions and customer experience planning. Hence the second research question (RQ2) asks:

RQ2: What distinct segments of passengers can be identified regarding preferences at key stages of the airport journey?

Segmentation is widely used in transportation research including in the specific area of air transport. For instance, Teichert et al. (2008) segment passengers by travel purpose and the different preferences regarding airline product attributes. Martinez-Garcia and Royo-Vela (2010) segment low-cost airline users based on perceived quality of the flight and destination with passenger and trip characteristics added as explanatory variables. These include gender, age, nationality, education, income, trip type and travel purpose. Budd et al. (2014) segment airport passengers using attitude statements to identify those with the greatest potential to reduce car use as their means of ground access to the airport. The segmentation includes travel purpose. Lu (2017) segments passengers using full-service and low-cost carriers according to service preferences with passenger and trip characteristics added as explanatory variables. These include gender, age, education, income, travel frequency and travel purpose. Studies typically consider a combination of psychographic and/or behavioural criteria along with passenger and/or trip characteristics. This is important because passenger or trip characteristics alone are rarely sufficient in capturing heterogeneity among customers (Tkaczynski et al., 2009).

Passenger preferences at key stages of the airport journey are used as the predominant segmentation criterion in this study. In line with previous studies (Budd et al., 2014; Lu, 2017; Martinez-Garcia and Royo-Vela, 2010; Teichert et al., 2008) passenger and trip characteristics are included as explanatory variables. Additionally, privacy and human dignity are recognised by Royakkers et al. (2018) as key social and ethical issues associated with the use of digital technologies. Human dignity includes concerns about dehumanisation (standardisation of people) and unemployment (standardisation of jobs). The interest and willingness of passengers to adopt digital technologies may be influenced by their opinions about social and ethical issues associated with them. Privacy and human dignity are therefore also included as explanatory variables for any segments that are identified in this study. Hence research question three (RQ3) asks:

RQ3: How do segments vary according to passenger and trip characteristics and opinions about the use of digital technologies at airports?

3. Methodology

3.1. Survey design and data collection

A survey of airport passengers was used to collect data needed for the analysis. The survey began with questions on trip characteristics. This was followed by questions on passenger preferences at key stages of the airport journey. Respondents were asked to complete the survey as if they were taking the exact same trip as their current one at some point in the next 12 months. The survey ended with questions on privacy, human dignity and passenger characteristics.

The survey was developed in collaboration with Avinor (operator of 44 airports in Norway). An initial draft of the survey was developed by the authors with input from several contacts at Avinor. A workshop was then held with six senior staff at Avinor with responsibility for commercial digitalisation, information and communications technology (ICT), the passenger experience, strategy, and research and development to finalise the survey. Several decisions were made at this stage. For instance, to focus on departing rather than both departing and arriving passengers (the latter is more complicated as passengers are often in a rush to exit the airport compared to the former where passengers can be more easily approached while sitting at the departure gate). The original plan was to cover 'door-to-door' passenger preferences that include stages associated with journey planning, transport to/from the airport, the flight, customs, immigration, and baggage reclaim. However, a decision was taken to focus on key stages 'at the airport' in order to reduce survey length. Besides, it is unlikely that passenger preferences (for technology adoption) vary significantly for additional stages. Similarly, a question on transfer services was omitted because of the limited use of such services at the majority of airports in Norway.

The survey was then tested extensively via a pre-test with over 250 participants and a pilot with 100 departing passengers at Oslo Airport. The testing period resulted in several minor changes being made to wording, question order and rules. For instance, the survey asked all respondents to answer questions about preferences regarding bag tag and bag drop. However, not all passengers travel with checked-in baggage so a routing question was introduced to ask: 'Would you travel with checked-in baggage?' Response options to questions were randomised to avoid any bias associated with respondents selecting options that appear first. Also, a question asking respondents which airport they were departing from was added to the survey so that the individuals administering the survey did not need to record the information themselves.

The final survey was distributed to departing passengers at eight

airports in Norway between October and December 2019 (Table 1). Collectively, the airports served 91% of total passengers in Norway in 2019 and represent a good spread of the country with at least one airport from each of the main regions, and two to three each from the geographically larger regions of western and northern Norway. Data was collected via a computer-assisted self-interviewing survey method where passengers completed the survey themselves on an electronic device. All departing passengers were eligible to take part. Random sampling was used based on the counting principle. This was done by approaching every third or fifth passenger sitting at the gate, depending on the size of the gate. Gates serving domestic and international destinations were included to capture a range of trip characteristics. The survey was available in two languages; Norwegian and English.

3.2. Key variables

The airport journey is broken down into seven key stages: Boarding pass, Bag tag, Bag drop, ID, Security, Payment and Service. Survey questions and response options for each stage were developed in collaboration with Avinor based on a combination of options that are already available at Avinor airports, several that are currently under consideration or being tested out, and a few that are more long-term considerations (Table 2). Respondents could select one option for each question in Table 2, except for the Service variable where respondents could select up to five options. The original plan was to just have three response options for the Service question, from which respondents could select one: Staff in person, Self-service, and Augmented reality or artificial intelligence. However, there was a specific interest among members of the research group, including Avinor, to provide respondents with additional choices in order to better gauge the level of interest among respondents for more innovative and less familiar options such as chatbots, robots and holograms. For the purpose of this analysis, the Service variable was reduced to three categories: (1) Staff only for those that only selected: Staff, Phone/video or Online chat; (2) Self-service for those that selected any Staff only option and at least one of two Self-service options: Touchscreen or QR codes; (3) Augmented reality or artificial intelligence (AR/AI) for those that selected any Staff only or Self-service option and at least one of four AR/AI options: Chatbot, Robot, Hologram or AR.

For passenger and trip characteristics, age was split into four groups (18–24, 25–44, 45–64, 65+). Remaining variables were dichotomised as follows: gender (male, female), highest completed education (postgraduate degree or above, less than a postgraduate degree), annual household income before tax (NOK 600,000+, <NOK 600,000), nationality (Norwegian, other), return flights taken during the last 12 months (1–5, 6+), travel purpose (business, leisure), and type of trip (domestic, international). For passenger opinions regarding privacy and human dignity, three questions were used: (1) Privacy: 'How concerned are you about the potential use of digital technologies at this airport and the privacy of information about you?' (2) Standardisation of people: 'How concerned are you that digitalisation reduces human qualities at this airport such as personality, spirit, and the ability to socialise?' (3) Standardisation of jobs: 'How concerned are you that digitalisation reduces skills and results in the unlearning of skills required to carry out jobs at this airport?' Responses were recorded on a scale of one to five (1 Not at all concerned, 2 Not so concerned, 3 Moderately concerned, 4 Fairly concerned, 5 Very concerned).

3.3. Data analysis

To answer RQ1, a frequency analysis is conducted on passenger preferences. Regarding segmentation (RQ2), there are two main approaches available to researchers: (1) Posteriori – using statistical analysis to determine segments; (2) A priori – when segments are predetermined. This study uses cluster analysis for the former. To establish if there is rationale for clustering respondents and if so, into how many clusters, a TwoStep Cluster Analysis is used. Cluster analysis has become a popular way of identifying segments based on survey data (Dolnicar, 2002). More specifically, TwoStep Cluster Analysis has been widely used in travel and transportation research to identify homogeneous groups (Abas et al., 2018; Groβe et al., 2018; Hadjikakou et al., 2014; Hsu et al., 2006; Kamruzzaman et al., 2013, 2014a, 2014b, 2015, 2018; Pitombo et al., 2011; Rasmi et al., 2014; Ritchie et al., 2016; Tiago et al., 2016; Tkaczynski and Rundle-Thiele, 2013; Tkaczynski et al., 2010, 2015). The analysis is easily conducted using the statistical software platform SPSS Statistics. TwoStep Cluster Analysis is used due to its ability to handle categorical variables that are used in this study (it can also handle continuous variables simultaneously). In addition, TwoStep Cluster Analysis determines clusters automatically (Ballestar et al., 2018) and is able to handle large datasets (Tkaczynski et al., 2010). It is considered one of the most useful and objective selection criteria because it avoids the arbitrariness of traditional clustering techniques (Rundle-Thiele et al., 2015) thus allowing for the determination of segments within a dataset that would otherwise not be apparent.

In the first step, data is pre-clustered using log-likelihood distance as the similarity criterion. Next, data is combined in a sequential process using an existing pre-cluster or a new pre-cluster that generates the largest log-likelihood. In the second step, the pre-clusters are merged using agglomerative hierarchical clustering. Two options are available here: the Schwarz's Bayesian Information Criterion (BIC) (Schwarz, 1978) or the Akaike Information Criterion (AIC) (Akaike, 1973). Both options were used in the analysis and produced similar results. However, the results under BIC are reported in this paper because asymptotically BIC is consistent and therefore it tends to select the true number of clusters if the assumption of the existence of segments among the respondents is valid (Vrieze, 2012). Considering that previous studies have established segments among air transport passengers (e.g. Budd et al., 2014; Lu, 2017), it is plausible to assume that meaningful segments exist among passengers considered in this study and therefore BIC is deemed appropriate. To assess the model, consistency of the revealed segments is validated using the silhouette measure of cohesion (within-cluster distance) and separation (between-cluster distance), which should be

Table 1
Sample of airports.

Airport	Region	Passengers 2019 (million)[a]	Soft quota (%)[b]	Respondents (N)	Respondents (%)
Oslo	Eastern	28.6	23.0	1370	22.5
Bergen	Western	6.4	14.0	846	13.9
Trondheim	Central	4.4	14.0	831	13.7
Stavanger	Western	4.3	14.0	880	14.5
Bodø	Northern	1.7	9.0	537	8.8
Tromsø	Northern	2.3	9.0	536	8.8
Kristiansand	Southern	1.1	9.0	544	8.9
Molde	Western	0.4	9.0	538	8.8
Total	All	54.2	100.0	6082	100.0

[a] Data sourced from Avinor (2020).
[b] Target proportion of respondents at each airport based on airport size and a target sample of 6000 respondents.

Table 2
Survey questions and response options for key variables.

Wording in the survey	In this paper
How do you prefer to access your boarding pass?	Boarding pass
•Via a mobile application	•App
•Using a self-service kiosk	•Kiosk
•Via text/SMS	•Text/SMS
•With staff at a check-in desk	•Desk
•Via a website (and printed off myself)	•Website
What type of "tag" would you prefer to use to check your baggage in?	Bag tag
•Paper tag printed and attached by staff at a check-in desk	•Desk
•Paper tag printed at a self-service kiosk and attached by me	•Kiosk
•Paper tag I print (e.g. at home, work, hotel) and insert in a tag holder on my baggage	•Home
•Digital tag built-in to my baggage that can be updated from an application on my mobile device each time I travel, and used to track my baggage throughout its journey	•Digital
How would you prefer to "drop" your baggage?	Bag drop
•With staff at a check-in desk at the airport	•Desk
•Using a self-service bag drop at the airport	•Drop
•At the airport but before entering the terminal (e.g. airport car park, car rental)	•Pre-terminal
•At an off-airport location (e.g. train or bus station, downtown, cruise ship)	•Off-airport
•Pay to have it collected (e.g. from my home, office, hotel) by a company that checks it in at the airport for me	•Collection
What type of personal identification would you prefer to use at each check point?	ID
•Paper boarding pass combined with my passport or other ID card if necessary	•Paper
•Electronic boarding pass (e.g. on a mobile device, frequent flyer card or airline smart pass) combined with my passport or other ID card if necessary	•Electronic
•Biometric (e.g. pre-register my facial and travel details so I can then pass each check point by scanning my face **instead** of using a boarding pass, passport or other ID card)	•Biometric
If you need to pass through security, which option would you prefer to use?	Security
•Current process of scanning or showing my boarding pass, then removing items for screening before also being screened myself	•Current
•Use of infra-red cameras, facial recognition and other technologies that scan me as I move so that I can walk through security without needing to remove items for screening	•Biometric
If you need to purchase something at this airport, how would you prefer to pay?	Payment
•Cash	•Cash
•Credit or debit card	•Card
•Mobile payment application that connects card payments to phone numbers such as MobilePay and Vipps	•App - phone
•Mobile payment application using an e-wallet such as ApplePay, AliPay, Google Pay, PayPal, WeChat Pay	•App - wallet
Which customer information services would you prefer to use at this airport (assuming that all of them can answer any questions that you might have)?	Service
•Staff in person at an information desk or roaming the terminal	•Staff
•Staff via telephone or a video link	•Phone/ video
•Live online chat service with staff	•Online chat
•Touchscreen self-service information kiosks	•Touchscreen
•QR codes that provide information when you scan them using your mobile device	•QR codes
•Chatbot – an artificial intelligence that you can communicate with via an airport website, mobile application, messaging application, virtual voice assistant or kiosk	•Chatbot
•Robot that can provide assistance and scan your boarding pass to offer personalised information	•Robot
•Hologram - 3D image that looks like a real person and offers Siri-like interactivity and announcements	•Hologram
•Augmented reality where you look through the camera on your smartphone and information is superimposed onto what you see	•AR

above zero (Norušis, 2012; Rundle-Thiele et al., 2015). The algorithm computes Predictor Importance scores for each variable, which should be greater than 0.02 (Norušis, 2012). Chi-square tests are then used to confirm the significance of differences between the segments according to variables used to create them. According to Norušis (2012), all variables in the solution need to be statistically significant ($p < .05$) to validate the model. Regarding RQ3, ANOVA and Chi-square tests are used to examine differences between segments according to explanatory variables that were not used to create the segments. This includes passenger and trip characteristics and opinions about social and ethical issues associated with the use of digital technologies at airports.

4. Findings and discussion

4.1. Frequency analysis

Passenger and trip characteristics of respondents are shown in Table 3. Not all passengers travel with baggage to check-in so for the cluster analysis, the sample was split according to those that would travel 'with baggage' (68.8%, 4185 respondents) and those that would travel 'without baggage' (31.2%, 1897 respondents). In terms of differences, the group travelling without baggage has a higher proportion of male respondents, that are middle aged (24–44 years old), have a postgraduate education, a higher household income and flight frequency, and are travelling on domestic flights for business purposes.

Responses regarding passenger preferences are shown in Table 4. Mobile boarding passes were launched in Norway in 2009 by the airline SAS for passengers using Oslo and Stavanger airports but can now be used across the entire network of airports in Norway. Over 50% of respondents now prefer to use a mobile boarding pass (39% via a mobile application, 16% via text/SMS). However, almost half still prefer to use a paper boarding pass (27% via a self-service kiosk, 15% with staff at a check-in desk, 4% printed from a website).

Printed bag tags are the preferred option for respondents (40% at a self-service kiosk, 25% at a check-in desk, 4% self-printed). However, almost a third (32%) prefer to use a digital tag. This is a high proportion given that digital tags are not commonly used or known about. Indeed, a digital bag tag was only used for the first time in Norway by former Minister of Trade and Industry Torbjørn Røe Isaksen on a domestic flight in 2018. Digital tags offer an opportunity to replace the printing of approximately 20 million tags annually in Norway alone.

Self-service bag drops were introduced in Norway at Tromsø Airport in 2008 and are now common at airports in Norway. Two thirds of respondents (66%) prefer to use this option while 25% prefer to drop their baggage with staff at a check-in desk at the airport. Only 6% prefer to drop their baggage at the airport but before entering the terminal and 1% prefer to drop their baggage at an off-airport location. Two percent prefer to pay for it to be collected and this is largely those travelling with additional or outsize baggage. The lack of interest in off-terminal or off-airport bag drop options is a surprise given that such options are increasingly introduced at airports. However, this could be specific to airports in Norway where it is relatively easy for passengers to travel to and from them with their baggage.

Another area of interest to airports is the introduction of biometrics for ID management. However, only 16% of respondents prefer to use biometric ID. The electronic boarding pass combined with a printed passport or other ID card is the most preferred option (52%). About a third (32%) prefer to use a paper boarding pass combined with a printed passport or other ID card. The lack of interest in biometric ID may not necessarily be due to a fear of using it. Instead, it might be that electronic or paper options are viewed by passengers as being sufficient at airports in Norway. Supporting this notion, interest in biometrics at security is much higher. Over half of all respondents (53%) prefer the use of infra-red cameras, facial recognition and other technologies that scan them as they move so that they can walk through security without needing to remove items for screening before being screened themselves. Security screening is a common stress point for passengers at airports where queues are common. Interest in using biometrics at security may be higher than it is for ID because passengers feel there is greater value to be gained from it.

Mobile payment applications have become popular in Norway in

Table 3
Passenger and trip characteristics.

Variable	Characteristic	Total		With baggage		Without baggage	
		N	%	N	%	N	%
Total		6082	100.0	4185	68.8	1897	31.2
Gender	Male	3370	55.4	2230	53.3	1140	60.1
	Female	2607	42.9	1886	45.1	721	38.0
	Other/prefer not to say	105	1.7	69	1.6	36	1.9
Age	18-24	865	14.2	633	15.1	232	12.2
	25-44	3079	50.7	2042	48.8	1037	54.7
	45-64	1915	31.5	1339	32.0	576	30.4
	65+	223	3.7	171	4.1	52	2.7
Education	Postgraduate	1975	32.5	1115	26.6	860	45.3
	<Postgraduate	4107	67.5	3070	73.4	1037	54.7
Income	600 k+	3340	54.9	2164	51.7	1176	61.9
	<600 k	2132	35.1	1574	37.6	558	29.5
	Prefer not to say	610	10.0	447	10.7	163	8.6
Flights	6+	2856	47.0	1761	42.1	1095	57.7
	<6	3226	53.0	2424	57.9	802	42.3
Nationality	Norwegian	4647	76.4	3150	75.3	1497	78.9
	Foreign	1435	23.6	1035	24.7	400	21.1
Type of trip	Domestic	4322	71.1	2850	68.1	1472	77.6
	International	1760	28.9	1335	31.9	425	22.4
Travel purpose	Business	2817	46.3	1641	44.9	1176	62.0
	Leisure	2573	42.3	2013	48.1	560	29.5
	Other	692	11.4	531	12.7	161	8.5

Note: 'Other' and 'Prefer not to say' responses were treated as missing values in the analysis.

Table 4
Responses for variables relating to key stages of the airport journey.

Variable	Option	N	%
Boarding pass	App	2362	38.8
	Kiosk	1614	26.5
	Text/SMS	943	15.5
	Desk	936	15.4
	Website	227	3.7
Bag tag	Desk	1028	24.6
	Kiosk	1657	39.6
	Home	168	4.0
	Digital	1332	31.8
Bag drop	Desk	1040	24.9
	Drop	2771	66.2
	Pre-terminal	231	5.5
	Off-airport	57	1.4
	Collection	86	2.1
ID	Paper	1926	31.7
	Electronic	3187	52.4
	Biometric	969	15.9
Security	Current	2854	46.9
	Biometric	3228	53.1
Payment	Cash	222	3.7
	Card	4276	70.3
	App	1584	26.0
Service	Staff only[a]	1379	22.7
	Self-service[b]	2242	36.9
	AR/AI[c]	2461	40.5

[a] Staff only for those that only selected Staff, Phone/video or Online chat.
[b] Self-service for those that selected any Staff only option but also Touchscreen or QR codes.
[c] AR/AI for those that selected any Staff only or Self-service option but also Chatbot, Robot, Hologram or AR.

recent years. In particular, one called Vipps, which was developed by the bank DNB and released in 2015 is widely used. Over a quarter of respondents (26%) prefer to use a mobile payment application when purchasing products and services at airports in Norway, of which 20% prefer to use an application that connects card payments to phone numbers. A further 6% prefer to use an e-wallet. Credit or debit card is however still the most popular method of payment, preferred by 70% of respondents. Only 4% prefer to use cash. It is worth noting that the preference for using a credit or debit card instead of a mobile payment application may stem from ingrained habits and/or a lack of knowledge about the advantages of using this newer form of payment, which is in fact generally considered to be a more secure method of payment than using a credit card.

There are high levels of interest in using digital technologies at airports in Norway to access customer services. Unlike other variables where respondents could only select one option, respondents could select up to five from a list of nine options for the Service variable. This is reduced to three options in Table 4. However, of the nine options, Staff was the most popular (selected by 58% respondents), followed by Touchscreen (53%), QR codes (21%), Phone/video (18%), Online chat (18%), Chatbot (17%), AR (16%), Hologram (14%) and Robot (13%). This shows that passengers prefer to deal with staff in person when in need of customer services. However, they are also willing to use digital solutions as alternatives. If passengers can be assured that staff/human intervention is available if needed when using digital solutions, there may be even greater interest in using them. However, this was not addressed in the current study.

4.2. Cluster analysis

Seven inputs (variables) are used for passengers with baggage. Five inputs are used for passengers without baggage. All inputs are treated as categorical variables in the analysis. Schwarz's Bayesian Criterion (BIC) is used as the clustering criterion and log-likelihood is used as the distance measure (Table 5).

Fifteen clusters are computed in SPSS by default. However, only the first five are shown in Table 5 as they provide sufficient information. The algorithm recommends three clusters for each of the two groups (with and without baggage) with a fair degree of cluster quality (average silhouette measure of cohesion and separation of 0.2 for both groups) that exceeds the minimum expected measure of zero (Norušis, 2012; Rundle-Thiele et al., 2015). The predictor importance of each input is shown in Fig. 1. Cluster quality improves when removing the last two inputs with predictor importance values of less than 0.7. However, they are retained for the clusters because they provide useful insights and meet the expected requirement of being greater than 0.02 (Norušis, 2012). Cluster distributions are shown in Fig. 2. Respondents fit into one of the three clusters for each group. The clusters have been labelled as 'Manual', 'Automated' and 'Personalised' to reflect the varying degrees

Table 5
Auto-clustering using Schwarz's Bayesian Criterion (BIC).

Clusters	With baggage				Without baggage			
	BIC	BIC change[a]	Ratio of changes[b]	Ratio of distance[c]	BIC	BIC change[a]	Ratio of changes[b]	Ratio of distance[c]
1	59183.098	–	–	–	17253.960	–	–	–
2	50585.775	−8597.323	1.000	2.085	14534.489	−2719.471	1.000	1.450
3	46539.724	−4046.051	.471	1.814	12684.147	−1850.342	.680	1.794
4	44377.018	−2162.706	.252	1.213	11689.758	−994.389	.366	1.146
5	42620.659	−1756.358	.204	1.214	10832.487	−857.271	.315	1.169

[a] The changes are from the previous number of clusters in the table.
[b] The ratios of changes are relative to the change for the two cluster solution.
[c] The ratios of distance measures are based on the current number of clusters against the previous number of clusters.

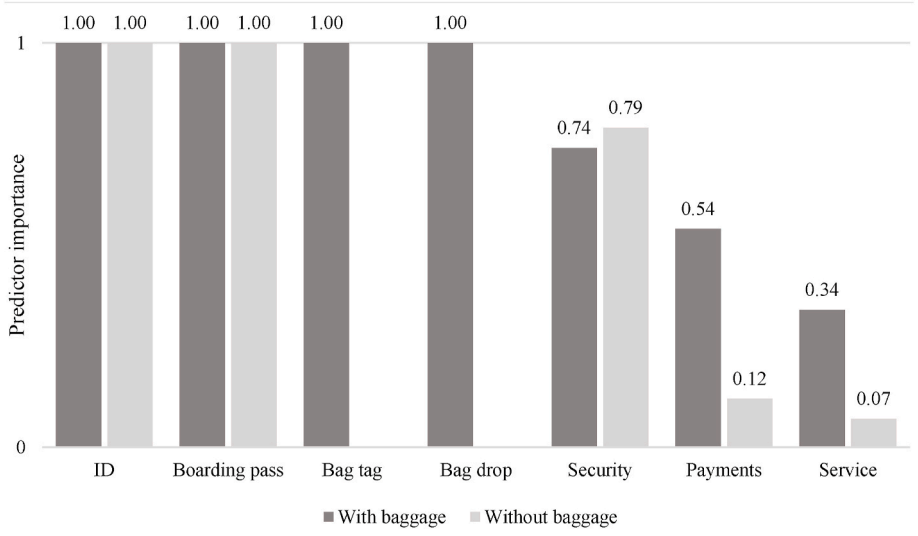

Fig. 1. Predictor importance of inputs.

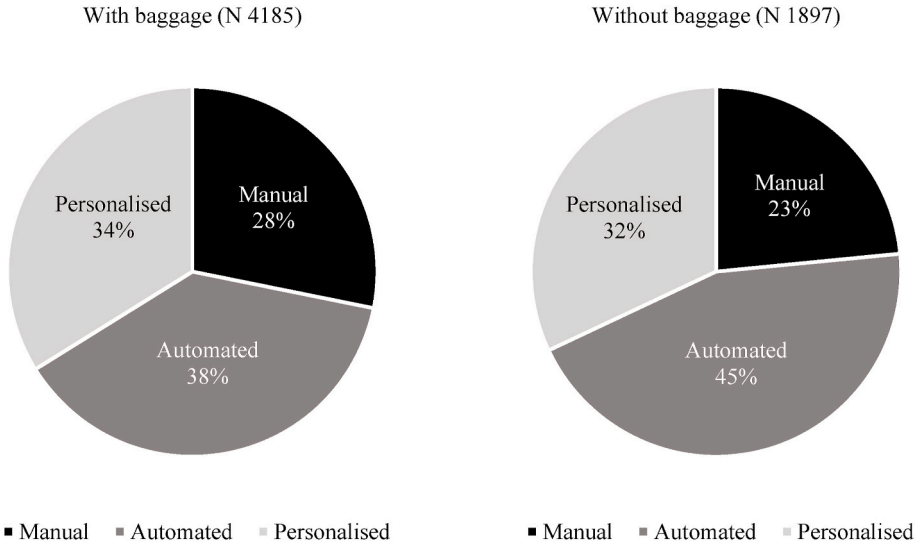

Fig. 2. Cluster distributions.

of interest in manual processes (Manual), automated and self-service technologies (Automated), and personalised technologies such as biometrics (Personalised). In response to RQ3, respondents that belong to the Automated and Personalised clusters are more likely to be business passengers and/or frequent flyers, have higher levels of income and education, and are less concerned about the privacy and human dignity impacts of using digital technologies at airports, compared to respondents that belong to the Manual clusters.

The ratio of sizes, which is the ratio of the largest to smallest cluster, are less than two for each group: (1.35 for passengers with baggage and 1.90 for passengers without baggage). From Fig. 2, it can be seen that the Automated clusters are the largest (38% of all passengers with baggage and 45% without baggage). A further 34% and 32% respectively then fit into the Personalised clusters. Only 28% and 23% of respondents

respectively fit into the Manual clusters. Cluster robustness was tested by repeating the analysis on half of the sample, selected at random, which resulted in three similar clusters for each group.

Cluster profiles for passengers travelling with and without baggage are shown in Tables 6 and 7 respectively. The significance of differences between the three clusters identified according to passenger preference variables is examined using Chi-square tests. This involves cross-classification and testing for independence between the three clusters and the profile variables by computing: a chi-square statistic (χ^2); degrees of freedom (df), which is given by the formula: (number of rows-1) (number of columns-1); and the p-value. In line with Norušis (2012), all clusters are significant ($p < .05$) (Table 8). The significance of differences between the clusters according to passenger and trip characteristics is then examined using Chi-square tests (Tables 9 and 10). There are significant differences between passenger and trip characteristics of the two groups where almost all of the differences are significant ($p < .05$). Fig. 3 and Fig. 4 show mean scores for each cluster and ANOVA test results which examine significant differences between each cluster according to their response to questions on privacy and human dignity by computing: a test statistic (F); degrees of freedom (df) between groups and within groups; and significance (p-value). All are significant ($p < .05$). The three clusters are described as follows:

Manual clusters. Passengers belonging to the Manual clusters (with and without baggage) prefer to use paper-based forms of personal ID. If travelling with baggage, they prefer to check their bag in with staff at a check-in desk, where they also prefer to receive their boarding pass. If travelling without baggage, they prefer to access their boarding pass at a self-service kiosk, meaning there is some overlap between the Manual and Automated cluster for passengers travelling without baggage. Passengers belonging to the Manual clusters (with and without baggage) prefer to use the current process of removing items for screening at security. If they need to make a purchase, they prefer to use a debit or credit card. If in need of customer services, they are more likely than other clusters to prefer to use staff only.

Passengers belonging to the Manual clusters (with and without baggage) are mainly travelling for leisure versus business purposes, and there is a higher proportion of foreigners and those taking international trips than the other two clusters. There is also a significantly higher proportion of older passengers aged 65 or more. Compared with the other clusters, there is also a lower proportion of passengers with postgraduate education, a household income of NOK 600,000 or more, and a flight frequency of six or more trips. They also have the highest levels of concern regarding privacy and human dignity.

Table 6
Clusters for passengers travelling with baggage.

		Proportion of respondents (%) for each option by cluster		
Variable	Option	Manual	Automated	Personalised
ID	Paper	76.4	44.1	0.2
	Electronic	20.4	54.6	56.7
	Biometric	3.2	1.3	43.0
Boarding pass	Desk	69.8	0.4	1.6
	Kiosk	13.8	61.9	14.7
	Website	5.1	2.8	3.5
	Text/SMS	5.1	11.3	16.1
	App	6.2	23.7	64.1
Bag tag	Desk	81.8	2.5	1.6
	Kiosk	10.4	78.7	19.9
	Home	4.7	2.6	5.0
	Digital	3.1	16.0	73.5
Bag drop	Desk	68.7	8.1	0.0
	Drop	24.1	89.8	74.7
	Pre-terminal	0.0	0.0	10.0
	Off-airport	0.5	0.6	2.9
	Collection	0.3	0.5	5.3
Security	Current	51.9	74.6	15.6
	Biometric	48.1	25.4	84.4
Payments	Cash	9.2	3.4	0.8
	Card	83.3	78.9	48.7
	App	7.5	17.7	50.5
Service	Staff only	35.6	24.9	8.5
	Self-service	21.7	47.1	34.1
	AR/AI	42.7	28.0	57.4

Table 7
Clusters for passengers travelling without baggage.

		Proportion of respondents (%) for each option by cluster		
Variable	Option	Manual	Automated	Personalised
ID	Paper	72.1	0.0	0.0
	Electronic	22.5	100.0	54.4
	Biometric	5.4	0.0	45.6
Boarding pass	Desk	19.1	0.0	0.0
	Kiosk	56.4	0.0	1.2
	Website	15.7	0.0	0.5
	Text/SMS	4.5	33.1	29.0
	App	4.3	66.9	69.4
Security	Current	60.0	49.9	23.6
	Biometric	39.1	50.1	76.4
Payments	Cash	0.0	0.0	0.0
	Card	82.9	100.0	22.4
	App	11.5	0.0	73.8
Service	Staff only	28.5	27.6	13.7
	Self-service	44.9	41.1	33.8
	AR/AI	26.5	31.0	52.6

Table 8
Chi-square results for each cluster according to passenger preference variables.

	With baggage			Without baggage		
	χ^2	df	p-value	χ^2	df	p-value
Cluster*ID	2214.436	4	.000	1833.804	4	.000
Cluster*Boarding pass	3470.900	8	.000	1635.923	8	.000
Cluster*Bag tag	4416.757	6	.000	–	–	–
Cluster*Bag drop	1996.887	8	.000	–	–	–
Cluster*Security	1052.483	2	.000	166.556	2	.000
Cluster*Payments	781.900	4	.000	1132.323	4	.000
Cluster*Service	497.744	4	.000	106.331	4	.000

Automated clusters. Passengers that belong to the Automated clusters (with and without baggage) prefer to use electronic forms of personal ID, they prefer to use a debit or credit card if they need to make a purchase, and they prefer to use self-service options to access customer services. If travelling with baggage, they prefer to access their boarding pass and bag tag from a self-service kiosk and use a self-service bag drop, while those travelling without baggage prefer to access their boarding pass via a mobile application. If travelling with baggage, they prefer to use the current process of removing items for screening at security, while those travelling without baggage prefer to use biometrics.

The subtle differences between those travelling with and without baggage are because of the differences in passenger and trip characteristics. Passengers travelling without baggage are more likely to be business travellers than those travelling with baggage, who are more likely to be leisure passengers. The 'without baggage' group has a much greater proportion of males that are middle-aged with postgraduate education, and a higher income and flight frequency compared to those with baggage. However, the 'with baggage' group still has a greater proportion of passengers with postgraduate education, and a higher income and flight frequency compared to the Manual clusters. The Automated clusters sit between the Manual and Personalised clusters in terms of concerns regarding privacy and human dignity.

Personalised clusters. Passengers that belong to the Personalised clusters (with and without baggage) prefer to use electronic forms of personal ID. However, they also have the greatest level of interest in using biometric ID – almost half prefer this option regardless of whether they are travelling with or without baggage. They prefer to access their

Table 9
Chi-square results for each cluster according to passenger and trip characteristics (with baggage).

		Respondents in each cluster (%)			χ^2	df	p-value
Variable	Characteristic	Manual	Automated	Personalised			
Purpose	Business	33.7	37.3	46.0	45.222	2	.000
	Leisure	66.3	62.7	54.0			
Trip	Domestic	65.6	70.6	67.3	8.262	2	.016
	International	34.4	29.4	32.7			
Nationality	Norwegian	72.4	76.5	76.3	7.097	2	.029
	Foreign	27.6	23.5	23.7			
Gender	Male	59.9	49.7	54.4	27.978	2	.000
	Female	40.1	50.3	45.6			
Age	18-24	10.1	18.8	15.2	70.486	6	.000
	25-44	54.3	42.9	49.8			
	45-64	30.6	32.2	32.9			
	65+	5.0	5.2	2.1			
Education	Postgraduate	24.7	26.1	28.9	6.408	2	.041
	<Postgraduate	75.3	73.9	71.1			
Income	600 k+	51.4	54.8	66.2	60.446	2	.000
	<600 k	48.6	45.2	33.8			
Flights	6+	27.9	44.5	51.2	148.976	2	.000
	<6	72.1	55.5	48.8			

Table 10
Chi-square results for each cluster according to passenger and trip characteristics (without baggage).

		Respondents in each cluster (%)			χ^2	df	p-value
Variable	Characteristic	Manual	Automated	Personalised			
Purpose	Business	48.1	65.4	67.4	48.255	2	.000
	Leisure	51.9	34.6	32.6			
Trip	Domestic	72.1	77.6	81.5	13.090	2	.001
	International	27.9	22.4	18.5			
Nationality	Norwegian	72.4	79.4	83.0	17.797	2	.000
	Foreign	27.6	20.6	17.0			
Gender	Male	57.4	61.1	64.2	4.938	2	.085
	Female	42.6	38.9	35.8			
Age	18-24	14.8	10.8	12.4	62.919	6	.000
	25-44	46.7	60.0	53.0			
	45-64	31.2	27.3	33.9			
	65+	7.2	1.9	0.7			
Education	Postgraduate	35.5	50.2	45.8	25.397	2	.000
	<Postgraduate	64.5	49.8	54.2			
Income	600 k+	59.3	69.4	71.5	17.291	2	.000
	<600 k	40.7	30.6	28.5			
Flights	6+	44.9	59.8	64.3	41.818	2	.000
	<6	55.1	40.2	35.7			

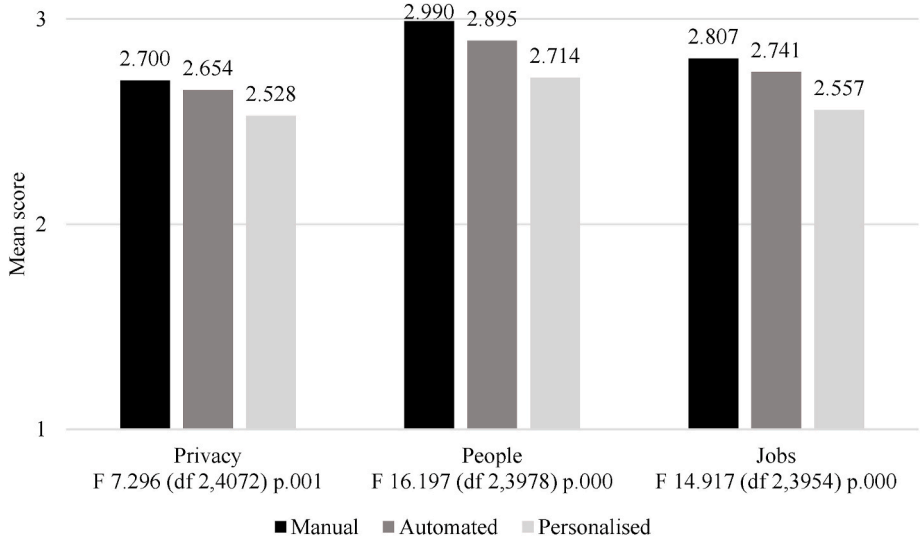

Fig. 3. Mean scores and ANOVA results for privacy, people and jobs by cluster (with baggage).

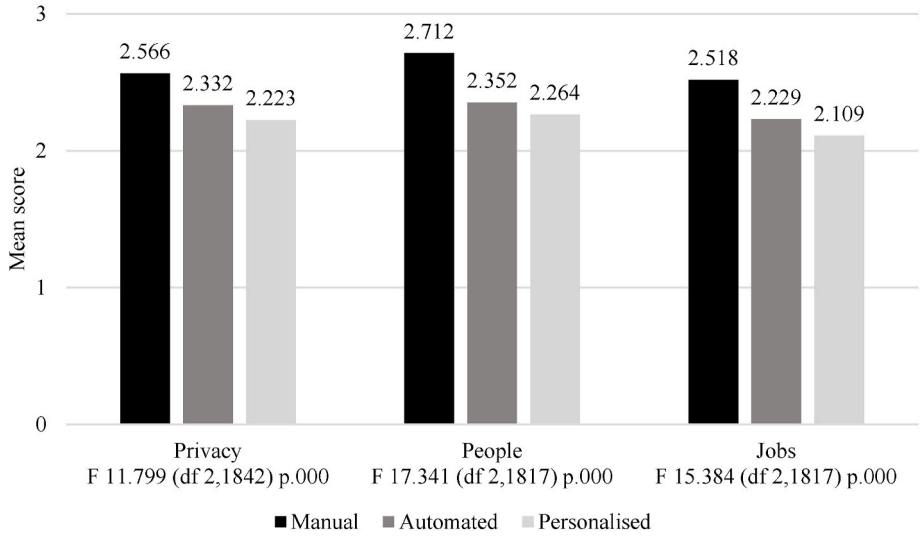

Fig. 4. Mean scores and ANOVA results for privacy, people and jobs by cluster (without baggage).

boarding pass via a mobile application. They are the only cluster to prefer to use a digital bag tag if travelling with baggage. Of all clusters, they are most interested in off-airport options if travelling with baggage. For instance, 10% prefer to drop baggage at the airport but before entering the terminal. They have the greatest level of interest for biometric security screening. In addition, they are the only cluster to prefer payments via a mobile application and they have the least interest in the staff only option for customer services – instead preferring AR/AI or self-service. Of all clusters, they have the greatest proportion of business travellers. This is especially the case for those travelling without baggage that tend to be male, Norwegians and on domestic trips. The Personalised clusters (with and without baggage) are least likely of all clusters to be aged 65 or more. They are most likely to have a post-graduate education, and a high household income and flight frequency. They have the lowest levels of concern regarding privacy and human dignity.

5. Conclusion

5.1. Contributions and implications

This study aimed to answer three RQs: RQ1. What are the preferences of passengers at key stages of the airport journey? RQ2. What distinct segments of passengers can be identified regarding preferences at key stages of the airport journey? RQ3. How do segments vary according to passenger and trip characteristics and opinions about the use of digital technologies at airports? In response to RQ1, this study finds that a large proportion of passengers now want more control over their journey with automated and/or more personalised options. Specific examples are the interest in mobile-based boarding passes, payments and services; digital bag tags; and the use of biometrics and other technologies at security. By exploring passenger preferences, this study contributes to a more granular understanding of experiential aspects of the airport journey. Findings point clearly towards the greater technology adoption by passengers, with a large proportion seemingly wanting more control over their journey with automated and/or more personalised options that provide a seamless airport experience. The findings support those of previous studies by IATA (2019) and SITA (2019b) that suggest high levels of adoption of digital technology among passengers. However, the findings also highlight the considerable diversity in passenger preferences and opinions regarding digital technology adoption. Specifically, there remains a small yet significant group of passengers more reticent to adopting digital technologies as part of their journey.

In response to RQ2, passengers are grouped according to their preferences using cluster-based segmentation analysis. Three distinct segments for passengers travelling with and without baggage are identified: Manual, Automated and Personalised. The Automated and Personalised clusters are dominated by passengers with preferences for using digital technologies. The former is more in favour of automated and self-service technologies while the latter is more in favour of a personalised technology-based experience. In response to RQ3, respondents that belong to the Automated and Personalised clusters are more likely to be business passengers and/or frequent flyers, have higher levels of income and education, and are less concerned about the privacy and human dignity impacts of using digital technologies at airports, compared to respondents that belong to the Manual clusters. The Manual clusters are dominated by passengers with a preference for manual processes if travelling with baggage or a combination of manual and automated processes if travelling without baggage. The without baggage group therefore also has preferences for using digital technologies for some airport processes. Differences between passengers travelling with and without baggage have not been addressed in previous studies but as the findings of this study show, the two groups of passengers have slightly different characteristics and preferences.

From a management perspective, the need for segmentation is based on the assumption that it is not possible to address the preferences of each individual but that it is possible to reveal homogeneous groups of preferences that can be targeted with innovations or existing products and services. Currently, for airports this means offering technological solutions for passengers that want them, and manual processes for those who prefer more traditional approaches. An example of this is check-in, where it is common to see staffed check-in desks, self-service kiosks, bag-drops and/or entirely mobile paperless processes in the same airport. While this helps to meet the needs of different groups, it results in multiple ways of conducting the same process. This can lead to inefficiencies, inconsistent service levels and confusion among passengers, especially when processes vary according to airport or even between different airlines at the same airport.

The extent to which airports will be able (or willing) to continue to accommodate diverse passenger expectations in this way will likely depend on a number of factors, both internal and external in nature. From an internal organisational standpoint, an airport will look to its current and/or desired passenger mix and market position to guide investment decisions on technology adoption. For example, it could be expected that a large hub airport with a strong focus on business traffic, where speed and reliability of the passenger experience is likely to be valued more highly, would seek to adopt digital technologies more

readily than a smaller regional airport focussing on seasonal leisure traffic. It is possible that airport business models, and the services they offer, will become more diversified as result.

Interestingly, the findings of this study suggest that there may be value for some airports, especially those catering to particular passenger segments, promoting a more 'traditional', 'humanised' approach to the passenger experience. There are examples of this trend in other sectors including insurance, banking and sales, where the ability to speak to a *real* person is widely seen as a valuable and marketable commodity.

In terms of external forces, the ongoing impacts of the COVID-19 crisis and recovery of aviation cannot be overlooked here. It is notable that the data collection phase of this study was conducted prior to the outbreak of the pandemic. Airports can use the clusters in this study as a basis for identifying which groups of passengers are ready to adopt technologies that might help to overcome challenges associated with COVID-19, and which groups require additional information, assistance, or reassurance if they are to be forced away from using traditional manual processes. Moreover, in a post COVID-19 world, where physical distancing, 'enhanced' cleaning and touchless journeys may become part of a 'new normal' for the passenger experience, it remains to be seen how passenger expectations will change alongside this. It is quite conceivable that a passenger who once valued the personal service offered by a member of staff at airports would now prefer more automated or personalised processes on the grounds of minimising risks of transmitting the virus.

5.2. Limitations and further research

Like virtually all passenger studies of this nature, the present study is limited to departing passengers due to the difficulties associated with surveying arriving passengers – the latter tend to exit the airport as soon as possible while the former can be surveyed while waiting at the gate for their flight. This inevitably means that consideration of passenger preferences for key stages of the arrival process (e.g. arrival at the terminal, border control, baggage reclaim, customs, arrival landside, and access to surface transport) are not captured. However, it makes intuitive sense that passenger preferences would remain broadly consistent for both departure and arrival; it is unlikely a passenger who favored digital processes and technology adoption on departure would have strongly contrasting views at their arrival airport, and vice versa.

This study was limited to seven key stages of the airport journey (and only five for those travelling without baggage). It did not collect data on other aspects such as wayfinding due to considerations on survey length, however this is recognised as an important aspect of the passenger experience and could represent an avenue for further research. Equally, while social and ethical considerations were included in the survey, the measurement of these variables was limited to one question on privacy and two on human dignity. The variation in opinions warrants additional research on this topic, including more general attitudes towards the role of technology in society and everyday life.

Respondents stated their 'preferences'. There could be situations where respondents are quite happy with one or more alternatives that they did not select, which is not picked up in the analysis. In addition, the questions are prone to hypothetical bias when individuals may not behave consistently in situations where they do not have to back up their choices with real action (Hensher, 2010). This is especially the case for preferences that have a financial cost, for instance, digital bag tags versus printed tags at the airport. While respondents may select preferences that have a financial cost in the survey, they may not be willing to do so in practice. It would therefore be interesting to conduct willingness to pay research for such options. Another approach that could be used productively to examine preferences (and willingness to pay issues) in this type of research is conjoint or tradeoff analysis.

Data collection took place at airports in Norway. While the overall findings are expected to be transferable to airports in other countries, there are likely to be local variations to consider, for instance, depending on passenger or airport characteristics, or what technologies are already used, and therefore experienced by passengers at the airport. The latter is important because passengers may be more cautious about selecting options that they are not familiar with. User experience, and how this corresponds to preferences, as well as expectations regarding unfamiliar technologies, are interesting areas for further research. In addition, Norway is highly ranked in terms of digital progress, for instance, in third place out of 30 countries in Europe on the European Commission's Digital Economy and Society Index (EC, 2020). According to the index, Norway has a higher integration of digital technologies compared to most countries in Europe. This may of course affect preferences and the relative size of the three segments in Norway compared to in other countries. Further, Norway is characterised by the existence of a large number of small airports serving mainly domestic air services (as illustrated by the high proportion of respondents travelling for domestic purposes in this study in Table 3), and competition between airports is limited given that the vast majority of them are operated by Avinor as part of a national airport system. This means that passenger preferences in this study are orientated towards domestic passengers, and at airports where current options (and subsequent experiences of using different options), are fairly standard across all airports.

Finally, in terms of theory building, the segments identified in this study can be used as a basis for further studies. As an example, Morosan (2018) calls for further research to identify and validate possible moderators of the relationship between convenience and disclosure in air travel. The three distinct segments identified in this study can serve as a potential moderator variable in such studies in the sense that the willingness to trade-off information disclosure for convenience may depend on the segment to which a passenger belongs.

Author statement

Nigel Halpern: Conceptualisation, Methodology, Formal analysis, Writing – original draft, review & editing; Deodat Mwesiumo: Conceptualisation, Methodology, Formal analysis, Writing – original draft, review & editing; Thomas Budd: Conceptualisation, Methodology, Writing – original draft, review & editing; Pere Suau-Sanchez: Conceptualisation, Methodology, Writing – review & editing; Svein Bråthen: Conceptualisation, Methodology, Writing – review & editing.

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Segmentation of passenger preferences for using digital technologies at airports in Norway

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