Non-use of Automated Border Control Systems: Identifying Reasons and Solutions

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There are many reasons why passengers are unable or reluctant to use self-service e-gate systems. In order for designers to build better systems with higher uptake by end-users they need to have a more thorough understanding of the non-users. This paper investigates the reasons of non-use of Automated Border Control at European airports by applying Wyatt's taxonomy and adding an "unawares" category. It also presents possible solutions to turn current non-users into future users of e-gates.

Non-use. Automated Border Control. E-gates. Diffusion of Innovation. Self-Service Technologies (SSTs).

1. INTRODUCTION

Since 1994 the volume of global air traffic has almost doubled to 3.1 billion with an average annual growth rate of 4.3% (Gelhausen et al.: 2013). This trend is expected to continue over the next 20 years reaching over 6.4 billion passengers by 2030 (Boeing, 2013) and will have a serious impact on the capacity of airports. Border control will have to be maintained with a similar workforce having a much heavier workload. Higher numbers of passengers also means increased security and safety risks. And with a larger throughput of passengers it will be harder to satisfy customer's high service expectations. One way of accommodating future increases in passenger traffic while maintaining high levels of security, safety and service, is the use of innovative technology.

E-passport gates are automated self-service barriers operated by border forces and located at checkpoints in a number of airports across Europe. These self-service applications require end-users to operate a system with no intermediary. While border forces and airport management see e-passport gates as a secure and convenient alternative to the conventional border control process, not all passengers choose to use these new self-service technologies (SSTs). There are many reasons why passengers are unable or reluctant to use self-service systems. In order for designers to build better systems with higher uptake they need to have a more thorough understanding of the non-users. This paper investigates the reasons of non-use of Automated Border Control (ABC) and presents possible solutions to turn current non-users into future users of e-gates.

2. METHODOLOGY

This paper is partly based on research at two North-European airports with each between 50 and 60 million passengers per year. We carried out 155 face-to-face surveys to ask passengers about their experience with ABC and biometric systems. We also conducted in-depth expert interviews with border guards and border management. The interviews (lasting one to two hours) were recorded and transcribed for analysis. Furthermore, in June and July 2013 we were granted permission to observe passengers in the secure area of the airport, using a pre-defined observation list (Oostveen et al, 2014).

3. AUTOMATED BORDER CONTROL SYSTEMS

European ABC systems aim to allow passengers faster and more convenient border crossing while ensuring maximum security. To use an e-gate system eligible passengers have to place their e-passport face-down on the scanner. After successful scanning, the passenger positions himself in front of a camera, which captures a live image of the face and uses facial comparison to check that it is similar to the picture on the e-passport chip. Face recognition software identifies

a specific individual by analyzing and comparing patterns. If the information matches the passport photo, the gate automatically opens, otherwise If the information does not match, the passenger is referred to an officer for a traditional manual check.

At the moment, usage of ABC systems does not live up to the projected scenarios. The United Kingdom, for instance, has a high take-up of ABCs with currently 63 e-gates at 15 terminals across the country, but "they are currently underused because of past reliability problems and passengers' reluctance to use them" (UK Home Office, 2013). In Only 31 per cent of eligible passengers use the gates, which is below the Border Force's own target of 50 per cent.

Other European countries have identified the same problem. From our interviews with border guards and border management we learn that: "*The business case predicted that we should have 5.7 million [e-gate] users at our airport per year. We are now a year and a half underway and we have had our second million passenger just now. So it's falling well below*" (Interview, July 2013).

Another good indication of the limited use of e-gates, is the result from our passenger interviews: 76% (N=117) had never used a self-service e-gate. Of the non-users 75% (N=88) is completely unaware of the existence of this method of border control. (FastPass Passengers survey, June 2013).

The low uptake of a technology that has been in existence for several years, and that has become readily available at many European airports raises the question why so few travellers are using e-gates. As Satchell and Dourish (2009: 15) point out: "Non-use is often active, meaningful, motivated, considered, structured, specific, nuanced, directed, and productive".

4. A TAXONOMY OF NON-USERS

The Oxford Dictionary defines 'non-use' as "the refusal or failure to use something". In HCI research non-usage of technology has increasingly become a topic of study (Selwyn, 2003; Wyatt, 2003; Satchell & Dourish, 2009; Kellner et al., 2010; Baumer et al., 2013). Although most research still focuses on when and how people use technology, Baumer et al. (2013) argue, "examining non-use – when and how people do not use technology – is an equally informative line of inquiry" where the motivations of non-users can inform designers.

Our expert interviews inform us that both developers of e-gates and border management are concerned about the low uptake of ABC systems. They want to understand the barriers to use and the acceptance problems people experience. Technologies can be deemed inappropriate, undesirable, or unwanted (Baumer et al., 2013), or have external factors that limit their use. System designers look at "non-users" in terms of "potential users" and try to find solutions to increase usage.

In order to address the issue of high non-use of e-gates we need to identify the variety of reasons why people resist or reject the technology. Wyatt (2003) developed a theory about non-users of the Internet identifying four types of non-users: 1) The Resisters – those who do not want to use the technology; 2) The Rejecters – former users, who decided not to use the technology any longer; 3) The Excluded – those who can't use the technology, regardless of whether they want to or not; and 4) The Expelled – former users who do not have access anymore (who stopped involuntarily).

Besides making a distinction between those who have never used the technology, and those who have stopped using the technology, Wyatt focuses on non-use as being an intrinsic choice (resisters and rejecters) or caused by external constraints (the excluded and the expelled). In this paper we apply Wyatt's taxonomy to our study of the non-use of e-gates but add another relevant category of non-users: 5) The Unawares – those who do not know the technology exists.

4.1 The Resisters

To use self-service technologies (SSTs) such as e-gates, users must be convinced of their value before foregoing a full service alternative (Collier & Kimes, 2013). Self-service systems are often implemented because they are advantageous for service providers, reducing labour costs, freeing up personnel for other tasks, and increasing service availability. Numerous SSTs have come and gone in the past because of the inability of service providers to educate users on the reasons why an SST is a better option than other channel alternatives (ibid). Users are not naturally inclined to change from their present familiar way of doing things unless motivated to do so (Sadiq Sohail & Al-Jabri, 2013)

Resisters of ABC systems may not be convinced of the potential benefits of e-gates. During our observations we noticed that with all circumstances being equal (no queues at the e-gate or at the manual check), passengers who were initially headed towards the e-gates, would go through manual border control instead (Oostveen et al., 2014). This indicates that many travellers have a tendency to choose the familiar over the new.

Constructs such as 'computer fear' and 'technophobia' also provide established accounts of individuals' reticence to use new and unfamiliar information technologies (Selwyn, 2013). Other resisters might be those who have little ICT

experience or those who have concerns about their privacy or the use of biometrics.

4.1.1. How to turn resisters into users?

Rogers' Diffusion of Innovations is probably the best known theory trying to explain which factors will influence the adoption of new technology. To use a new technology, end-users need to be convinced of several characteristics. The most important ones being: *ease of use* (whether an individual believes that using a particular system would be free of physical and mental effort); *relative advantage* (whether an innovation is perceived as better than the idea it supersedes); and *compatibility* (whether an innovation is perceived as being consistent with existing values, needs, and past experiences).

To make resisters more prone to using e-gates, designers need to pay attention to the above characteristics that determine adoption.

Ease of Use and Relative Advantage

When we asked non-users about their reasons for not using e-gates the answers were varied. For those who were aware of the existence of ABC systems, the most common reason not to use them was the fact that they (26.2%) did not know *how* to use them.

Currently, new users (and infrequent travellers) are taking a lot of time to get through the e-gates. Many passengers experience problems with the scanning of their passports, not knowing where and how to place them onto the scanners. And although overall the facial recognition systems cause fewer problems, it is not always evident for travellers how to position themselves in front of the camera (Oostveen et al., 2014). This creates queues and sends a message to other passengers that they might as well use the traditional channel of service, as there does not seem to be a clear relative advantage. Improving the usability of the system and making it more intuitive will make e-gates a better alternative than manual border checks.

Compatibility

For some passengers e-gates might not be consistent with their existing privacy values. Those who refuse to use the e-gates because of concerns about information use or biometrics could be provided with clearer information about how their data is being used. Making clear to people that their data is only stored for a limited time, and explaining who will be using this data and for what purposes might mitigate the concerns people have somewhat.

4.2 The Rejecters

The rejecters of e-gates are those who have used the technology before but have decided to voluntarily stop using the SST. Although the e-gates are intended to reduce the time needed to go through border control, the passengers will sometimes experience service failures due to technical or human error. Both malfunctions and design issues might negatively impact on the passenger's experience of the effectiveness of the SST and lead to dissatisfaction and technology abandonment (Sasse, 2007).

Besides negative prior experience, actual use of the e-gates can make passengers aware of privacy concerns. Travellers might worry for what other purpose their biometrics might be used, so-called function creep. In our survey this reason was mentioned by 3% of the respondents. Actual use might make someone aware that they prefer direct interaction and assistance from border guards. Again, only 3% of our respondents gave this as a reason for not using e-gates.

In more extreme cases, citizens who feel that their personal information can be compromised as the result of the RFID chip being vulnerable to attack have sometimes damaged passport chips on purpose. Their concerns are that passport information might be read without the owners' knowledge or consent (also known as skimming or eavesdropping) by a government trying to track their movements (Chothia & Smirnov, 2010), a criminal trying to steal their identity (Calderoni & Maio, 2014), or someone just curious about their citizenship. Another concern, previously especially voiced in the United States is that the passport chip could act as a trigger to detonate a bomb when someone with an American passport walks by (Kleiner, 2005). In order to avoid these attacks, some people choose to deliberately destroy the chip or its antenna by hitting their e-passports with a hammer or by placing it in a microwave for a couple of seconds.

4.2.1. How to turn rejecters into users?

Many users interact with e-gates infrequently and in complex situations, such as travelling in an unknown context, under stress and fatigue (Pirelli, 2009). As travellers will stop using systems that have proven to be unreliable or cumbersome, a solution would be to provide better-designed systems with intuitive interfaces to enhance the usability and increase the overall appeal of e-gates for passengers.

Again, it could help to educate rejecters on data policies and practices. Furthermore, in order to avoid 'militant acts of resistance' (Kellner et al., 2010) such as the deliberate destruction of the passport chip, governments need to provide adequate protection of travel documents. All new generation US e-passports have a protective foil lining inside their covers, which works like a

'Faraday cage'. Currently, in Europe the integration of a thin metal mesh into the passport's cover to act as a shield when the passport cover is closed is a voluntary measure proposed within the International Civil Aviation Organization (ICAO) standards. Although the shielding would "hinder skimming, the attacker would still be able to passively eavesdrop when the shielding is removed during legitimate reader-to-token communication" (Hancke, 2011).

4.3 The Excluded

Many groups of passengers are excluded from using ABCs. At present, travellers cannot use old (non-eID) passports or national identity cards (regardless of whether they are biometric) at e-passport gates. The under 18s are also not permitted to use e-gates. Furthermore, wheelchair users or passengers with a height lower than 1.10m cannot be processed. 8% of our respondents said that they were not entitled to use the e-gates. Another 4% admitted not to know whether they were entitled to use the system.

Insufficient quality of the data on a passport is also an excluding factor. One of our border management interviewees noted that there are quality issues with the digital photographs in certain European passports: "*The quality of pictures in e-passports differs from country to country, and from picture to picture*". Research confirms that 5% of passport images contain serious deficiencies (Spreeuwers, Hendrikse & Gerritsen, 2012). Major issues include: poor contrast, compression artifacts, dust and hairs on photographs, cracks, bad scan lines, non-frontal pose, colour smudges or stains, blurred images, distorted aspect ratio (i.e. the face is vertically stretched or compressed), or wrong eye colour due to compression or red eye correction. But even when the quality of the passport photos is good there can still be a problem matching the photo to the live image, resulting from a permanent change in appearance of the passport holder since the biometric information was put on the document.

The context in which one travels can also form a barrier to using ABCs. For instance, people travelling in a larger party, with some members not entitled to use the system, will in general use the manual booths together with their fellow travellers. Travelling with small children is another important factor that excludes people from using e-gates.

4.3.1. How to turn the excluded into users?

There have been discussions whether or not to lower the age for eligible e-gate users to 16-years. In New Zealand lowering the age for SmartGate users let 120,000 more travellers use the kiosks every year, which benefitted families with teenagers, and high school groups who can self-process together. Broadening the age limit has clearly made the e-gates more flexible and encouraged passengers to use this technology.

Improving the quality of passport photos will further cut down the group of excluded travellers. All European countries should have the same robust guidelines for passport photos.

Another way in which more people can be included is to design more inclusive systems: a document scanner that would accept ID cards, cameras that go below the 1.10 meters to allow people of limited height, and wider e-gates enabling wheelchair access. The system should provide 'reasonable adjustment' so that disabled people are not disadvantaged.

4.4 The Expelled

The 'expelled' have used the system before, but are now unable to use the e-gates. For example, passengers may have a passport containing a damaged, defective, or otherwise nonfunctioning chip. Citizens sometimes destroy chips deliberately in order to protect their personal information against eavesdropping, skimming, cloning, and tracking attacks. This way the chip will be deactivated and cannot be read by unwanted persons without consent. But it also means that the passport can't be used for legitimate reasons such as going through ABC systems. At other times technical failure will make the chips unusable. A chip can be accidently destroyed in everyday use, for instance by sitting on it, folding it, or getting it wet.

Another possibility is that the biometric information on the passport does no longer match the live biometrics. When a person shows his genuine passport but the score falls below a certain threshold, it is known as a False Rejection. After severe burns or scarring fingerprints on a passport may fail being matched to the live prints. Facial comparison can fall below the threshold when somebody has had plastic surgery or has aged significantly. According to Schouten and Jacobs (2009) the facial appearance of young people or very old individuals may change quickly, while beards, moustaches and change of hairstyle can also affect the performance of systems.

4.4.1. How to turn the expelled into users?

When a passport contains a damaged, defective or otherwise nonfunctioning chip, the owner will have to apply for a new passport. In some cases when a chip can't be read, the machine readable zone (MRZ) chip and aerial can be cleaned using a soft dry cloth or tissue to remove any debris.

Another solution to reduce the number of expelled

travellers is to improve the biometrics recognition. Both the cameras capturing the live images and the biometrics software are still in the process of being further developed and improved.

4.5 The Unawares

In his seminal work Roger (1995) points out that innovations are adopted at a certain rate. He describes a recurring 'S-curve' of technology use in society with the following successive groups adopting a new technology: innovators, early adopters, early majority, late majority, and laggards. The unawares that we encountered in our research do not necessarily have an aversion to change (unlike Roger's 'laggards'), they have just not yet been confronted with the new technology. Our face-to-face survey with 155 passengers shows that about 57% of all the travellers were completely unaware of the existence of e-gates. Nearly a fifth of the non-users answered that they had never been in a place that had e-gates and were therefore unable to use them (18.4%), even though the airport where the surveys were conducted did have e-gates.

4.5.1. How to turn the unawares into users?

Information is key. On-board videos could be shown to make passengers aware of the technology and to show them how to use the system. When citizens apply, renew, change, or replace their passport they could receive a leaflet explaining what an e-passport is, how it can be used for ABCs, and where these systems are in use in Europe. Finally, travel agents could provide leaflets or notifications to their clients when they book a holiday.

Improving visibility of the e-gates is another means to increase awareness. At many airports signage to the e-gates is poor. People have to first walk past the manned booths to get to the e-gates. This means that many people might not be aware of the self-service system and instead queue up to be checked by a border guard. Simple alterations could make a huge difference in the uptake of ABCs, such as improving the signage and relocating e-gates so that they are placed before the manual boots. Another option is to use floorwalkers to direct passengers to the e-gates. Once one passenger uses the gates, others will follow. As one of our interviewees pointed out: *"If the normal desks are busy and no one sends them to the e-gates, people do just not see them or they are afraid of them, I do not know, but they do not present themselves spontaneously. However, if you do send a few people to it, then the rest follows as a herd. People like to join the end of a queue."*

One could argue that there is still a low uptake of e-gates because of the relative novelty of the technology. Perhaps getting the 'unaware group' to use ABC technology is just a question of time and patience. By increasing the availability of e-gates, people will more frequently be confronted with ABC systems when they travel and will gradually get used to them. They might also hear family and friends talk about them. Hopefully the 'early adopters' will have had positive experiences, in this way motivating others to use e-gates.

However, the unawares might become one of the other four types of non-users as described by Wyatt's taxonomy. For now, it is too early to know whether current non-use is going to be persistent, reflecting a principled stand taken by the individuals concerned. Once e-gates have been introduced at more airports and have become an established method of border control, we can see whether remaining non-use results from a deliberate choice to resist change, modernity, or the supremacy of technology (Kellner et al., 2010).

5. CONCLUSIONS

This paper confirms that non-users of technology do not fall into a homogeneous group (Kellner et al., 2010). By making a distinction between the different kinds of non-users, it becomes clearer for developers of ABC systems whether or how they can contribute to turning non-users into possible future users. The taxonomy showed that each category of non-users has its own set of possible solutions. The category of the 'unawares' is currently the most prevalent group of non-users. We can ask ourselves whether it pays off to invest time and energy in resolving issues related to the first four categories of non-users (i.e. resisters, rejecters, excluded and expelled), or whether we should direct our efforts only at the 'unawares' who make up the largest part (approximately 70%) of non-users?

In our opinion the first four categories of non-users cannot be ignored as their numbers may increase once more travellers become aware of e-gates, reducing the number of unawares. However, the analysis in this paper shows that many of the solutions described cannot be addressed by designers and developers of e-gates and are the responsibility of other organizations or institutes. For instance, *governments* will have to set stricter standards for passport photos, or might (together with the International Civil Aviation Organization) play a role in setting new regulations for the e-passport chips. *Passport providers* could issue passports with better protection against unauthorized access to sensitive information contained within the RFID chip by incorporating protective foil lining inside the passport covers.

But there are ways in which the *developers of e-gate systems* can address issues related to the

resisters, rejecters, excluded, and expelled. Improving the ease of use, re-designing the gates to make them more inclusive, and providing better document scanners (passport and ID card) and better facial recognition cameras/software will all contribute to a higher acceptance and uptake of ABCs. Other ways for developers to improve their systems and hence the usage, is to involve users continuously throughout the development process. Usability is central to a "mass market" adoption of technology (Satchell & Dourish, 2009).

Should we assume that time will solve the problem of the unawares or is there a need to actively push the technology? The rather technological deterministic 'time-will-solve-all' view argues that access to new innovations will inevitably lead to use: "While non-use is a natural consequence of the pattern of diffusion of technological adoption […] it is a temporary condition" (ibid. 2009:2). In other words, we just need to be patient and give e-gates time to appear at more border checks and reach a critical mass of users to accelerate the complete permeation of this innovation.

However, when we decide that an active push is needed, the question rises whose task is it to make the unawares 'aware'? Is it the airport, the travel agency, the passport provider, the e-gate manufacturer, or the border management? We think that in the coming decade it is a shared responsibility to educate passengers and raise awareness. And although designers cannot really directly make the unawares aware, they can reach them through the experience of current users. It is known that people will recommend systems if they have had a positive experience. Word-of-mouth is an excellent way of convincing those who have not used e-gates before to give it a go on their next travels.

6. REFERENCES

Baumer, E., P. Adams, V. Khovanskaya, et al. (2013) Limiting, Leaving, and (re)Lapsing: An Exploration of Facebook Non-Use Practices and Experiences. *CHI 2013*, Paris.

Baumer, E., J. Burrell, M. Ames, P. Dourish and J. Brubaker (2014) Refusing, Limiting, Departing: Why We Should Study Technology Non-use. Workshop at *CHI 2014*, Toronto.

Boeing (2013) *Current Market Outlook 2013-2032*.

Calderoni, L. and D. Maio (2014) Cloning and tampering threats in e-Passports. *Expert Systems with Applications*.

Chothia, T. and V. Smirnov (2010) A Traceability Attack against e-Passports. In: Financial Cryptography and Data Security. *Lecture Notes in Computer Science*, 6052, 20 - 34

Collier, J. and S. Kimes (2013) Only if it is convenient: understanding how convenience influences self-service technology evaluation. *Journal of Service Research,* 16(1), 39-51.

Hancke, G.P. (2011) Practical eavesdropping and skimming attacks on high-frequency RFID tokens. *Journal of Computer Security*, Vol. 19 (2), 259 – 288.

Gelhausen, M., P. Berster and D. Wilken (2013) Do airport capacity constraints have a serious impact on the future development of air traffic? *Journal of Air Transport Management*, 28, 3–13.

Kellner, C., L. Massou and P. Morelli (2010) (Re) Examining the Non-Use of ICT. *Questions de Communication*, 18.

Kleiner, K. (2005) Metal shields and encryption for US passports. *New Scientist*.

Oostveen, A., M. Kaufmann, E. Krempel and G. Grasemann (2014) Automated Border Control: A Comparative Usability Study At Two European Airports. *IHCI 2014 Conference. Lisbon.*

Pirelli, G. (2009) Usability in Public Services and Border Control. New Technologies and Challenges for People with Disability. European Commission, EUR 23987.

Rogers, E.M. (1995) *Diffusion of Innovations*. 4th Edition. New York: The Free Press.

Satchell, C. and P. Dourish (2009) Beyond the User: Use and Non-Use in HCI. *Australian Computer-Human Interaction Special Interest Group* (OZCHI '09). ACM, New York, NY: 9-16.

Sasse, A. (2007) Red-Eye Blink, Bendy Shuffle, and the Yuck Factor. A User Experience of Biometric Airport Systems. IEEE Security & Privacy, 78-81. IEEE Computer Society.

Sadiq Sohail, M. & I. Al-Jabri (2013) Attitudes towards mobile banking: are there any differences between users and non-users? *Behaviour & Information Technology*, 1-10.

Schouten, B. and B. Jacobs (2010) Biometrics and their use in e-passports. *Image and Vision Computing*, 27, 305 – 312.

Selwyn, N. (2003) Apart from technology: understanding people's non-use of information and communication technologies in everyday life. *Technology in Society*, 25, 99-116.

Spreeuwers, L, Hendrikse, A. and K Gerritsen (2012) Evaluation of Automatic Face Recognition for Automatic Border Control on Actual Data Recorded of Travelers at Schiphol Airport. International Conference of Biometrics Special Interest Group. Darmstadt, Germany, 1-6. Gesellschaft für Informatik

UK Home Office (2013) The Border Force: Securing the Border. HC 540, 2013-14, 1-44.

Wyatt, S. (2003) 'Non-users also matter: The construction of users and non-users of the Internet' in Oudshoorn and Pinch (eds.) *How Users Matter: The Co-construction of Users and Technology*, Cambridge, MA: MIT Press.