

# Human Factors Approach to Study Border Control Automation Impacts and Needs: Methodology and Preliminary Results of Field Studies

Elise Le Guellec<sup>1</sup>(✉), Christine Megard<sup>2</sup>, Grigore M. Havârneanu<sup>3</sup>,  
Sonia Huguenin<sup>2</sup>, Virginie Papillault<sup>3</sup>, Juliette Richoux<sup>1</sup>,  
and Sirra Toivonen<sup>4</sup>

<sup>1</sup> Thales Communications & Security S.A.S,

4 Avenue des Louvresses, 92230 Gennevilliers, France

{Elise.Leguellec, Juliette.Richoux}@thalesgroup.com

<sup>2</sup> Institut CARNOT CEA, LIST, DIASI/Laboratoire d'Interfaces Sensorielles et  
Ambiantes, CEA Saclay Nano-INNOV,

Point courrier 173, 91191 Gif sur Yvette Cedex, France

{Christine.Megard, Sonia.Huguenin}@cea.fr

<sup>3</sup> International Union of Railways, 16 rue Jean Rey, 75015 Paris, France

{Havarneanu, Papillault}@uic.org

<sup>4</sup> VTT Technical Research Centre of Finland,

Tekniikankatu 1, 33720 Tampere, Finland

Sirra.Toivonen@vtt.fi

**Abstract.** Passenger flows are continuously increasing in Europe and the number of border guards does not increase as quickly as it needs. The use of automatic systems such as e-gates and kiosks is envisaged to enhance security and to facilitate the border crossing. Border control activity should be thoroughly studied in order to understand in which ways it would be impacted by the introduction of more technological systems. The purpose of this study is to analyze the current border guards' activities from a human factor point of view and to provide recommendations and requirements regarding the introduction of the future regulation and the use of automatic systems. The paper introduces the methodology used to investigate human factors at four types of borders based on a systemic human factors approach, organizational factors, technical tools and environmental aspects.

**Keywords:** Automated border check · Border guards · Smart Borders · Europe · Man machine allocation · Cognitive models · Recommendations

## 1 Introduction

As traveler flows are continuously increasing in Europe, the current security checks at the European Union (EU) external borders can be very long and challenging. The new forecast published by Airbus [1] anticipates a air traffic growth of 4.5% annually and the number of Schengen border crossings in 2025 will possibly reach 887 million with one

third concerning Third Country Nationals (TCNs: any person who is not a EU citizens). At the same time, the increase of the number of border guards (BGs) will certainly not be able to cover the needs from the field. The EU wants to enhance security at the border toward TCN and to deploy means to track over stayers. The Smart Borders Initiative from EU plans to introduce an Entry/Exit system (EES) that would record entrance/exit dates and places in the Schengen area for TCN and data regarding any refusal of entry. The use of automated systems such as e-gates and kiosks is also envisaged to enhance traveler's flows at the border and to "facilitate" the border crossing of TCNs.

Border control is described in the Schengen code [2] by four main subtasks: check if the identity of the traveler matches with his/her identity document, checks the authenticity of the identity document, check the validity of the identity document and check if the traveler can be a threat. The study is focused on the activity at the first line which is the first check performed by border guards. In case of a doubt, the traveler is conducted to a second line. This first line activity should be especially considered in order to understand in which way it could be impacted by the introduction of more technological systems and automation. To our knowledge, the activity of border control has rarely been the subject of human factors publications. Despite the fact that the impact of automation on human factors has been largely addressed in the past three decades [3–5], most of the studies were related to disruptive technologies like cockpit automation. Very few were focusing on border control, except some on the impacts of e-gates on travelers [6].

The purpose of this study is to analyze the current border guards' activities from a human factor point of view and to provide recommendations and requirements on the introduction of the future regulation with EES and the use of automatic systems at the border.

This paper introduces the human factor methodology used in the EU research project BODEGA. The methodology is based on observations and interviews of different actors involved in the border control. The approach is based on a systemic view of border control activities, organizational factors and technical tools. The results of the field studies on these three dimensions will be presented. The analysis is partly based on Parasuraman and Sheridan's taxonomy of mental workload, situation awareness and skills degradation [5]. The paper ends with a discussion regarding the human factor issues that need to be considered for the implementation of the smart border initiative in Europe.

## 2 Methodology

The methodology used to identify needs and build up recommendations relative to present and future border check is based on a systemic human factor approach considering the entire end-users, from top management and trainers, to border guards and travelers. Other elements of the system like customs, port authorities, airlines, security, body control, sellers, have been considered regarding their relationship with border control. The study focuses on the analysis of the global activity (tasks performed by border guards), organization (team organization, interactions, etc.) and technologies used at border control. The tasks analysis focuses on the tasks performed in real settings. This framework, presented in by Keyser [7], relies on numerous studies

indicating that the work is rarely performed as prescribed. In real conditions of work, operators need to adapt the procedures with external constraints (high or very low passenger flow, weather conditions, technologies failure, etc.) and internal factors like motivation, stress, boredom, routine and many other factors that may influence the way to perform their work.

It is very important to catch the reality of the field to be able to provide recommendations and requirements for Smart Border Initiative matching with the current needs. Tasks analysis contains two main steps:

- The first step is the identification of the prescribed tasks and the goals that border guards have to achieve. The tasks define what the border guards have to do and in which order, to be able to achieve their goals. The prescribed tasks can be assessed thanks to official documents (for instance the Schengen code) and interviews with managers.
- The second step is the identification of the real tasks performed on the field and the understanding of the gap reasons between the prescribed tasks versus the real one. Observations and interviews are the main methodologies used to assess an overview of the whole activity.

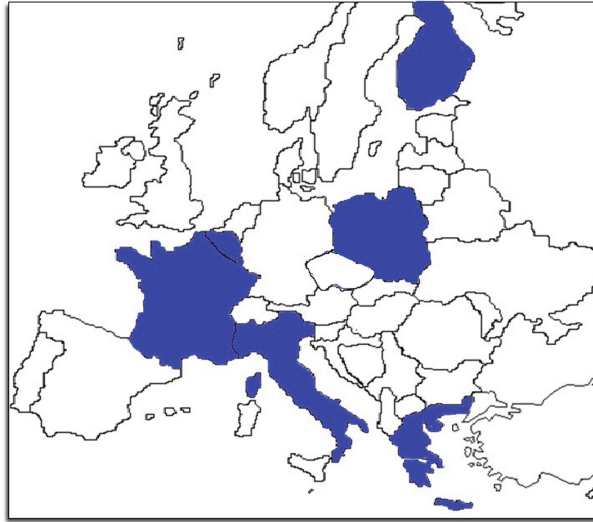
To achieve the goal to build a real vision of border guards' activity, field studies have been performed across Europe at each type of border crossing points: air, rail, land, port. For a collective analysis of the data, the BODEGA consortium partners defined a common methodology for data collection and analysis. The methodology was more focused on a qualitative collection rather than quantitative to get an in-depth view of the activity of border guards. It included:

- Interviews of border guards, managers, top managers, and trainers.
- Observations of border guards' activity.
- Observations of travelers at the border crossing point (behavior, interactions with BG or automated system ...), travelers' interviews.

The semi-structured interview guides included nine main categories which were built according to the goal of BODEGA project:

- Organization and management of the team: description of the organization in the team.
- Activities: description of how border check is performed concretely on the field and description of the task of border check in the legal framework of the Schengen code.
- Performance: factors that affect performance at border check.
- Soft Skills/Non-Technical Skills that contribute to enhance performance at border check.
- Training: description of how training contribute to the efficiency and effectiveness during border checks.
- Evolution of the BG's job and how border guards perceive their role in a prospective view.
- Environment Technology: description of the tools used at border check.
- Travelers view point: perception of border check by travelers.
- Ethics and legal framing.

All participants in the field studies were voluntary. They filled in a consent form accepting the confidentiality of the collected data. It is important to highlight that it has not always been easy to have access to the field due to several issues: time constraints, availabilities of the border guards, number of border guards in the border crossing point, recent terrorist attacks in Europe in particular in France and in Belgium. Several planned field studies were cancelled because of these events and others were postponed. Below is the overview of the countries where field studies have been conducted: Belgium, Finland, France, Greece, Italy, and Poland (Fig. 1).



**Fig. 1.** Overview of the countries where field studies have been performed.

The data collected from the field studies were integrated in an Excel sheet and grouped into the nine main categories (mentioned above) for further content analysis.

The data were coded to keep them confidential. For example, only the type of border (air, road, rail, and maritime) and the profile of the person (gender, age, etc.) were mentioned.

The qualitative data analysis was performed by profile and categories. Generally, the types of borders have been analyzed altogether but specificities were added when needed.

### 3 First Results

#### 3.1 Tasks Performed at Border Check

This section allocates the four prescribed subtasks, required by the Schengen code, into five main tasks that the border guards shall perform in their activity.

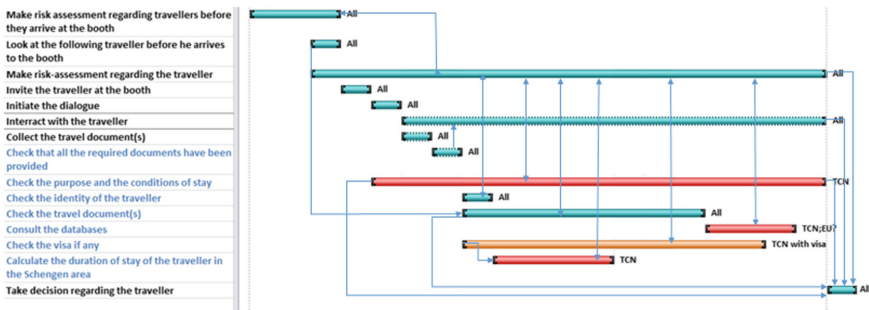
- Risk assessment performed beside border check: the observations at some borders have shown that border guards can contribute to risk analysis. They analyze the lists of travelers for a check in the databases before they arrive at the border. They proceed to an in-depth check of travelers if required. Border guards can also report statistics about stolen documents or falsification of documents.
- Risk assessment regarding the traveler: this main task contains two subtasks. The first one is relative to the appreciation of risk by the border guard before the traveler arrives in front of the BG. This covers broad observations performed before border, like waiting area, or in the queue. The other one relate to the risk assessment during the direct interaction with the traveler.
- Traveler identification: border guards check if the identity of the traveler matches with the information of his/her identity document (photo, nationality, ...). Border guards also verify if the data related to the identity of the traveler have not been modified. This main task is linked to the task in line with document verification but is strictly related to the check of the identity of the traveler. In addition to this task, the border guard has also to check if the traveler is not subject to an arrest warrant.
- Document verification: the border guard checks of the validity (date) and the authenticity of the identity document (looking for falsifications or forgeries). The border guards also assess the information on the document (sometimes a document is authentic but based on false data). He also has to check if the identity document is not stolen, misappropriated or invalidated.
- Eligibility check: this relies on the subtasks that are performed by border guards to ensure that the traveler fulfills all the conditions for entry/exit in the Schengen area for TCN travelers. Border guards check the databases to verify that the traveler is not a threat.

All these main tasks performed in the border guards' activity contribute to the decision making regarding the traveler.

The model presents in a time line, the different types of tasks, considering all steps of the process, from pre-risk assessment to decision making. The model shows how the general risk assessment regarding travelers before they arrive in front of the border guard contributes to the risk assessment of the individual traveler who is checked. The pre-assessment allows the border guard to adjust the level of risk if he detects 'something strange' in the behavior of the traveler. In that situation, the border guard will pay more attention during the check (see Fig. 2).

The model shows that the risk assessment with the traveler is performed during the all activity, the entire check and that each mandatory task related to the check (checks of the identity; check of the authenticity of the identity document and check the eligibility conditions) contributes to adjust the evaluation of the risk associated to the traveler. The tasks performed at border check contribute to decision making. The information gathered through the consultation of the databases, the check of the visa (with the Visa Information System (VIS)) or the calculation of the traveler in the Schengen area (for TCN only), also contributes to border guard's decision about one traveler.

The model supports the idea that the duration during which the border guard interacts with the traveler is of primary importance in the quality of the control.



### 3.2 Organizational Aspects

The local management of the team and the role of the manager are very important to organize the team, to encourage and motivate the BGs, to manage the information to the BGs, to give enough feedback about the BGs performance and give them useful information for their job. The team management needs to take into account versatility, flexibility and complementarity of the staff. The versatility of the BGs allows managers to assign them adequate roles in the work place. While some BGs would like to have specialized roles, others prefer to be more versatile. It seems that BGs are motivated when the organization allows them to perform several activities: first line checks, second line checks, writing reports and minutes – in other words being responsible for the whole process from the beginning until the end.

Team cooperation and exchange of information with other services are equally important. Communication exchanges between BGs helps them identify errors and learn from the experience of others. Sometimes informal meetings and debates are

organized to share their experience about specific cases. BGs work generally with many other services, depending on the type of BCP. In most cases these are the customs officers, or the BGs of the neighboring country. We noticed a huge disparity in the cooperation between BGs and the other services; some work closely, others not. Finally, communication and dissemination of information between the different BCPs are essential to improve the efficiency of border check especially concerning neighboring countries.

### 3.3 Technological Aspects

In the last years, border guards have seen several introductions of new technological tools in their job (inside booths); inter alia document reader and fingerprint recognition who have contribute to improve the control efficiency. Border guards appreciate these tools because they make them feel more confident about their decisions (let the traveler cross the border or not).

Smart Borders and the following establishment of the EU Entry-Exit system will be the next big (r)evolution (decision of the proposal is expected spring 2017 [8]). The proposed changes include additional biometrics verification, manual stamping withdrawal and the possibility for TCN citizens to use automated border checks systems (so far reserved for European citizens only). In summary, the proposal is expected to introduce more self-service kiosks and e-gates at the different border types.

Kiosks are not deployed yet in Europe but e-gates have been used in the largest European airports for years. Most of the fields observed did not have automated systems deployed and border guards had no information about the future evolutions expected. For this reason, they think that it is not possible to replace their knowledge, their skill and their expertise by machine. A main question is related to risk assessment activity that is a main activity of the border control process. This activity seems to be the most difficult to automate.

Technology failures could be an obstacle for the adoption of technological tools. If BGs consider that a tool adds more work, for example it makes the control time longer, they may not use the tool.

For border guards, having more technologies could be useful but they still want to keep control. For instance, they would like to have more technologies embedded inside the manual booth or kiosks before the booth control. In this way, tools help them to take decisions (confirm or not their first doubts about a traveler). In other words, border guards do not think that it is possible to be replaced by machines. For them, the final decision should stay human, which is also in line with the Smart Borders legislation proposal.

The main recommendations are that the technology deployed on the field should be mature and reliable enough to be accepted and used by border guards. Sometimes, the organization are not enough aware about the importance to provide a maintenance services in addition to the deployment of new tools.

Regarding automated systems, border guards' activity is affected. From an active position (control the travelers), they will be more into a passive one (supervise the automated control and react in case of problems). Though, it is well agreed that

automated machines always require human oversight. In future, border guards will probably operate more like alert spotters of anomalies rather than frontline passport-checkers [9].

The deployment of Smart Border should take into account: training, change management and to define a good balance to keep the border guards in the loop of the border control.

## 4 Discussion

During the last years, the border environment has evolved significantly with a more and more consequent passenger flow and the amplification of new risks such as terrorism. One border guard may check thousands of travelers weekly and he has a very short period of time to decide if the traveler is legitimate or not, and to assess if the traveler's documents are genuine. Border guards also should take into account urgent inputs regarding risk analysis for illegal immigration and the security of the member states.

From a distant viewpoint, border guard's job may seem boring due to the repetitive tasks to perform. However, the study showed that border guards' activity is more complex than just stamping passports. They find motivation in contributing actively to the security at the borders and in interacting with a diversity of travelers. Border checks are performed in close interaction with people from all over the world, speaking different languages, and with people from different religions, cultural habits and behaviors. These interactions are actual clues that help border guards to take decisions about travelers. It is an important part of the risk assessment activity.

One important thing learnt on the field was the importance of experience in border guards' job. They have basic training to learn about border control, but most of their skills are learned on the field thanks to the practice and the interactions within the team. Their skills are mainly composed by soft skills, which were hard for them to explain.

The results of the study highlighted the diversity of the processes between the different types of borders and the necessity for the border guard to be flexible enough to deal with the changing situations in their daily activities. The introduction of new technologies should be studied by taking into account the type of borders but also the infrastructure constraints, which appeared to be important issues. There cannot be enough space to install e-gates, therefore self-service kiosks seem to be more adapted in these cases. The traveler population characteristics should be also considered because they are not the same between:

- Road and rail borders with lot of daily travelers and few nationalities.
- Air borders with lot of nationalities.
- Maritime borders with many elderly travelers who need assistance and are not so comfortable about using technology by themselves.

With the introduction of automated systems, travelers diversity should be considered and the deployed systems should be adapted for most of them.

The study showed that the change management and the training of border guards are not always following the introduction of new technologies, even though they are important to ensure that the technologies are understood and used in the proper way.



The level of the border guards' trust in automated systems also needs to be addressed. The machine has to be a tool to help them. Border guards should keep their role on the risk assessment that they are currently performing during the manual control.

The tasks allocations between man and machine in EES implementation should be carefully studied before the deployment of e-gates and kiosks, because they can affect border guards' activities, border security, technology implementation and finally also the organization's activities.

To go further in this analyze regarding new technologies, it is necessary to go on additional fields which use automated systems because the main observed fields during the first part of this study do not have yet any automated technologies deployed.

**Acknowledgements.** This work was conducted under the BODEGA project (Proactive Enhancement of Human Performance in Border Control; <http://bodega-project.eu>). This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 653676.

## References

1. Airbus (2016) <http://www.airbus.com/company/market/global-market-forecast-2016-2035/>
2. Schengen Code: Regulation (EU) 2016/399 of the European Parliament and of the Council of 9 March 2016 on a Union Code on the rules governing the movement of persons across borders (Schengen Borders Code). ELI: <http://data.europa.eu/eli/reg/2016/399/oj>
3. Bainbridge, L.: Brief paper: Ironies of automation. *Automatica* **19**(6), 775–779 (1983)
4. Parasuraman, R., Riley, V.: Humans and automation: use, misuse, disuse, abuse. *Hum. Factors* **39**(2), 230–253 (1997)
5. Parasuraman, R., Sheridan, T.B.: A model for types and levels of human interaction with automation. *IEEE Trans. Syst. Man Cybern. Part A Syst. Hum.* **30**(3), 286–297 (2000)
6. Oostveen, A.-M.: Non-use of automated border control systems: identifying reasons and solutions. In: *HCI 2014 - Sand, Sea and Sky - Holiday HCI Proceedings of the 28th International BCS Human Computer Interaction Conference (HCI 2014)*, Southport, UK, 9–12 September 2014
7. Keyser, D.: Work analysis in French language ergonomics. *Ergonomics* **34**, 653–669 (1991)
8. COM (2016)194: Proposal for establishing an Entry/Exit System (EES) to register entry and exit data and refusal of entry data of third country nationals crossing the external borders of the Member States of the European Union and determining the conditions for access to the EES for law enforcement purposes and amending Regulation (EC) No. 767/2008 and Regulation (EU) No. 1077/2011. <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52016PC0194>
9. Fergusson, J.: Twelve seconds to decide. Frontex (2014). [http://frontex.europa.eu/assets/Publications/General/12\\_seconds\\_to\\_decide.epub](http://frontex.europa.eu/assets/Publications/General/12_seconds_to_decide.epub), ISBN 978-92-95033-92-4

Advances in Human Factors, Software, and Systems  
Engineering

Proceedings of the AHFE 2017 International  
Conference on Human Factors, Software, and Systems  
Engineering, July 17-21, 2017, The Westin Bonaventure  
Hotel, Los Angeles, California, USA

Ahram, T.Z.; Karwowski, W. (Eds.)

2018, X, 196 p. 62 illus., Softcover

ISBN: 978-3-319-60010-9