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Digitalization and official food safety inspections at retail establishments

Eduard Grau-Noguer [a,b,*], Remo Suppi [c], Maica Rodríguez-Sanz [b,d,e], Jordi Serratosa [f], Assun Bolao [b,e], Janne Lundén [g], Patrick Hau [h], Filipa Melo de Vasconcelos [i], Riikka Åberg [j], Cecilia Blomgren [k], Michel Lambert [l], Keidi Leppik [m], Ivar Vågsholm [n], Arja Helena Kautto [n,o], Johannes Lueckl [p], Sarah Abeln-Richter [q], Rolf Kamphausen [r], Erno Bammens [s], Filippos Georgiades [t], Jānis Altenburgs [u], Samuel Portaña [b,e]

[a] Departament de Ciència Animal i dels Aliments, Facultat de Veterinària, Universitat Autònoma de Barcelona, Cerdanyola Del Vallès, Barcelona, Spain
[b] Agència de Salut Pública de Barcelona (Public Health Agency, Barcelona, ASPB), Barcelona, Spain
[c] Departament d'Arquitectura de Computadors i Sistemes Operatius, Escola d'Enginyeria, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Barcelona, Spain
[d] CIBER Epidemiología y Salud Pública (CIBERESP), Madrid, Spain
[e] Institut d'Investigació Biomèdica (IIB Sant Pau), Barcelona, Spain
[f] German Federal Institute for Risk Assessment (BfR), Berlin, Germany
[g] Department of Food Hygiene and Environmental Health, Faculty of Veterinary Medicine, University of Helsinki, Helsinki, Finland
[h] Luxemburg Veterinary and Food Administration (ALVA), Ministry of Agriculture, Viticulture and Rural Development, Luxembourg
[i] Economic and Food Safety Authority (ASAE), Lisbon, Portugal
[j] Food Safety Unit, Environmental Services, City of Helsinki, Helsinki, Finland
[k] Environmental Health Services, City of Porvoo, Porvoo, Finland
[l] Federal Agency for the Safety of the Food Chain (FAVV-AFSCA), Brussels, Belgium
[m] Agriculture and Food Board, Tallinn, Estonia
[n] Department of Biomedical Sciences and Veterinary Public Health, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden
[o] Department of Control Support, Swedish National Food Agency, Uppsala, Sweden
[p] Department of Data, Statistics and Risk Assessment, Austrian Agency for Health and Food Safety (AGES), Graz, Austria
[q] Ministry of Food, Agriculture and Consumer Protection of the State of Lower Saxony, Hannover, Germany
[r] Ministry for Environment, Agriculture, Conservation and Consumer Protection of the State of North Rhine-Westphalia (MULNV), Düsseldorf, Germany
[s] Netherlands Food and Consumer Product Safety Authority (NVWA), Utrecht, Netherlands
[t] Environmental and Public Health Services, Ministry of Health, Nicosia, Cyprus
[u] Food and Veterinary Service, Ministry of Agriculture, Riga, Latvia

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ABSTRACT

Digital technologies offer unprecedented opportunities to modernize official food safety control. Shift from paper- to digital-based systems enable recording and reporting data directly in digital format and further analyze and disclose inspection data. Further to this, digital technologies enable the automatization of processes through rule-based instructions, a fact that could positively influence the consistency of official control. Nevertheless, the extent of the use of digital technologies during official food safety control inspections by competent authorities (CAs) of European Union (EU) countries is not known. For this reason, the aim of this study was to assess the level of use of a digital environment during inspections at retail establishments. This was performed by administering a questionnaire to CAs from EU countries. A total of 88 national, regional or local CAs from 15 EU countries responded to the questionnaire. Of them, 62.5% (55/88) used a digital environment during inspections, the majority to standardize data collection and reporting. CAs autotomize processes through digital technologies related to the management of official control and generation of inspection results, but to a lesser extent to automatize decision-making during inspections. Of the CAs not using a digital environment (37.5%; 33/88), technological constraints and lack of economic resources were the two most prevalent reasons for not using such an environment. The use of digital technologies as decision support tools to standardize official controls and improve consistency and efficiency should be enhanced for the benefit of society.

* Corresponding author. Departament de Ciència Animal i dels Aliments, Facultat de Veterinària, Universitat Autònoma de Barcelona, Cerdanyola Del Vallès, Barcelona, Spain.
E-mail addresses: eduard.grau@uab.cat, egrau@aspb.cat (E. Grau-Noguer).

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1. Introduction

Official food safety control ('official control' hereafter) seeks to protect public health by verifying and enforcing compliance with food law along the food chain (FAO/WHO, 2013). Law enforcement is performed by the designated official food control competent authorities (CAs) in each territory according to its given competences and in cooperation with the rest of CAs (EC 178/2002; EU 2017/625). In the European Union (EU), methods and techniques for official controls include on-site inspection of food premises, audits or food sampling and analysis (EU 2017/625). CAs should document all controls performed through written records, either on paper or in digital forms. Those records should include a description of the aim of the official control, the control methods applied, its outcome and if necessary, the measures required to the food business operators (FBOs) to correct the observed non-compliances. Different enforcement measures can be taken to ensure compliance, depending on the type and severity of the non-compliances.

Although CAs have flexibility on how to organize and enforce official control, Regulation 2017/625 (EU 2017/625) along with the Codex Alimentarius *Principles and guidelines for national food control systems* (FAO/WHO, 2013) clearly state that official controls should be risk-based and performed in a consistent, effective and impartial manner. Further to this, CAs should perform official controls with a high degree of transparency and publish information about the organization and performance of official controls at least once a year. There is consensus that these requirements can be achieved if official controls are performed in a systematic and reliable way (Griffith, 2005; Jones et al., 2004; Läikkö-Roto et al., 2015; Lee et al., 2010, 2012). Failing in keeping official controls at high levels of those requirements may result in unequal economic burden and dissatisfaction among FBOs, leading to their distrust against CAs (Blanc, 2012; Buckley, 2015; Kaskela et al., 2019; Läikkö-Roto et al., 2015; Yapp & Fairman, 2006).

Digital technologies enable standardized electronic data collection, recording and reporting in real-time from a variety of sources such as databases or handheld devices via wireless signals (Das & Mao, 2020; Donaghy et al., 2021; Labrique et al., 2013; Oppong et al., 2021). This data can be massively stored in cloud servers, processed, published and used to detect and forecast patterns (Eckert & Waidner, 2019; FAO, 2022; Park et al., 2021). Besides, digital technologies can also be employed as decision support tools for task scheduling and decision-making through automated algorithm- and rule-based instructions (Labrique et al., 2013; Odone et al., 2019; Park et al., 2021). Those technologies positively contribute to improving patency, transparency, and accountability of public administrations along with citizen trust in them (Janssen, 2011). It is believed that the use of digital technologies during official food safety control inspections ('inspections' hereafter) benefit official control by increasing the detection of non-compliances as well as recording consistent and useable data during inspections for their following analysis (Griffith, 2005; Kahneman et al., 2021; Zhe Jin & Lee, 2014).

In spite of the promising benefits offered by digital technologies, their implementation in the public sector is still slow and applicability underutilized (Bertot et al., 2010; El-Haddadeh et al., 2013; Maiti & Awasthi, 2020; Meijer, 2015). Reluctance to use digital technologies in the public sector can range from behavioral, practical to economic reasons (Statens Offentliga Utredningar, 2016). Despite digital technologies being tested to perform remote official control post-mortem meat inspections in Sweden (Almqvist et al., 2021; Kautto, 2022) and used to document official meat control results in different EU countries (Alban et al., 2022), in the EU the extent of the use of digital technologies in inspections is not known. Acknowledging how digital technologies can positively support inspections, it is important to know how widely they are used, for which purpose and the results of using such technologies. Further to this, if they are not used, it is also relevant to understand the reasons why they are not utilized.

Considering the lack of scientific literature about the application of digital technologies in inspections, the Barcelona Public Health Agency started a research project called "Digital transformation of the official food safety control in Barcelona". This project aims to support the development and implementation of a digital environment during inspections through research, as well as study its effects on inspections and to what extent such technologies are used by other CAs. A digital environment is seen as the context where digital tools (e.g., apps or programs) and devices (e.g., smartphones or tablets) are used to record, analyze, transmit data or facilitate communication and collaboration between CAs, FBOs and other stakeholders (food safety consultants, consumers, etc.) along the food chain.

The application of digital technologies in official control has been already discussed in international forums like the International Forum on Food Safety and Trade organized between the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO) and the World Trade Organization (WTO) (WHO, 2019) or the Vienna Food Safety Forum 2022 (UNIDO, Australian Government & STDF, 2022). Thus, given the lack of research addressing the usage of those technologies in this field, framed by the above-mentioned project, the goal of this research was 1) to assess the use of a digital environment during on-site inspections at the retail level by surveying CAs in different EU countries. For those CAs that used a digital environment the study aimed to investigate 2) the reasons why they were using it, 3) the results after using such an environment, 4) the inspection processes carried out through such an environment and 5) how it was developed and implemented. For those CAs not using a digital environment during inspections, this investigation also aimed to inquire into the 6) reasons why they were not using a digital environment during inspections.

2. Material and methods

2.1. Design of the questionnaire

Following the experience of developing and implementing a digital environment during inspections in Barcelona city by the Barcelona Public Health Agency, an initial questionnaire was designed using the theoretical framework of digital transformation in public administrations developed by Mergel et al. (2019) as a basis for its structure. This framework distinguishes the following four core blocks: 1) reasons for the digital transformation, 2) what is digitally transformed, 3) how it is digitally transformed and 4) the results of such transformation (output, outcomes and impacts).

The final version of the questionnaire consisted of 30 mainly close-ended questions distributed among 7 sections: 1) profile of the respondent CA and territory, 2) use of a digital environment during inspections (whether such an environment is being used by the CA or not), 3) reasons for using a digital environment during inspections (internal, those reasons that come from within the CA, and external, those reasons that come from outside the CA), 4) results of using a digital environment during inspections (internal, those results that impact within the CA, and external, those results that impact outside the CA), 5) inspection processes carried out through a digital environment (during and after inspections), 6) development and implementation process of a digital environment during inspections and 7) reasons for not using a digital environment during inspections. Close-ended questions with a fixed number of options inquired into the reasons for and results of using a digital environment during inspections as well as the reasons for not using a digital environment on a five-point Likert scale format ranging from 1 (Totally disagree) to 5 (Totally agree). Close-ended questions were also formulated with the intention to ask CAs to describe whether given specific inspection processes were carried out through a digital environment on a three-option scale (1 = Not carried out at all, 2 = Carried out but not through a digital environment and 3 = Carried out through a digital environment). Multiple-answer and Yes/No questions were formulated to enquire how CAs developed and implemented a

digital environment. Further to this, each section concluded with open-ended questions with the objective to allow CAs to expand their answers provided in the close-ended questions. The original questionnaire was prepared in English and translated into Spanish and German.

2.2. Validation of the questionnaire

A first draft of the questionnaire was shared with 25 experts on official control from CAs from 12 EU countries: Austria, Belgium, Cyprus, Estonia, Finland, Germany, Latvia, Luxembourg, Netherlands, Portugal, Spain and Sweden. Experts were first approached through a purposive sampling method and further experts were contacted through snowball sampling (Marcus et al., 2017; Schreier, 2018). An expert was considered any person involved in the management of official control from national, regional or local CAs, and a CA any authority designated by the participating countries responsible for carrying out official control (EU 2017/625). Experts were asked to critically revise, provide comments and suggest further questions. Based on the experts' input, the questionnaire was accordingly refined.

2.3. Pilot of the questionnaire

The questionnaire was piloted with 40 local CAs from the Province of Barcelona (Spain). Recruiting was carried out using snowball sampling through a call launched by the Deputation of Barcelona and interested CAs were asked to voluntarily complete the questionnaire. The questionnaire was administered using the web-based Microsoft Office Forms®. This software enables users to publish on-line self-completion surveys and collect their responses. Initially, the questionnaire was meant to collect answers from control officers ('officers' hereafter), control chief officers and control managers from each of the participating CA. However, after the pilot of the questionnaire, the approach of the questionnaire aimed to collect only one answer per CA, representing the whole CA.

2.4. Administration of the questionnaire and study participants

The final version of the questionnaire was uploaded to Microsoft Office Forms®. The link to the survey was directly shared with all 27 EU countries through the Heads of Food Safety Agencies group. This group of senior officials from all national food safety agencies from all EU countries is an informal working party that represents governmental administrations responsible for food safety risk management (European Commission, n.d.). Participation in the study was voluntary. Based on the distribution of official control competences of each participating country, the survey was sent to either national, regional (departments, federal states or autonomous communities), supra-municipal (group of municipalities) or local CAs (municipalities, districts and counties). For those countries where control was enforced in different levels than national, contact persons from the national CAs helped in distributing the questionnaire.

The survey was administered during April and May 2022. Two reminders were sent during this period. Before the survey, we informed the CAs about the aim, scope and significance of the study. Further to this, CAs were invited to contact the first author of this study directly in case of questions and doubts when answering the questionnaire.

2.5. Data analysis

CAs' responses were exported into Microsoft Office Excel®. Results were presented through descriptive statistics. Responses to the open-ended question were presented when they added value and more information than in the close-ended questions.

For this study, it was acknowledged that all participating CAs were self-governed and not vertical subordinate regional or/and local of a superior CA. Therefore, each CA was considered as a single unit of study regardless of being national, regional, or local, and no differentiation was made between them when analyzing the results.

3. Results

3.1. Use of a digital environment during inspections

Eighty-eight CAs from 15 EU countries responded to the questionnaire. Of the participating countries, official control at the retail level is enforced by the national CAs or their vertical subordinate regional or/and local units in 10 countries (Belgium, Denmark, Estonia, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal and Romania), by the national and municipal CAs, under the supervision of the national CA, in 1 country (Cyprus) and by either regional, supra-municipal or municipal CAs in 4 countries (Austria, Finland, Germany and Spain) (Fig. 1). For those countries where official control is centralized and the country where control is shared between the central and local CAs, 1 answer was submitted by each national CA (n = 11), while for those countries where control is decentralized a total of 77 answers were submitted by regional, supra-municipal or local authorities. Of those answers, 8 were submitted by CAs from Austria, 22 from Finland, 21 from Germany and 26 from Spain.

Of the CAs, 62.5% (55/88) used a digital environment during inspections while 37.5% (33/88) did not use such an environment during inspections at all. From the 55 CAs that use a digital environment, tablets (60.0%; 33/55) and laptops (58.2%; 32/55) were the most popular digital devices used, followed by smartphones (50,9%; 28/55). The mean year when CAs started using a digital environment was 2014, ranging from 2000 to 2022. There were two unclear answers and thus they were considered as missing data.

3.2. Reasons for using a digital environment during inspections

Among the 55 CAs that used a digital environment during inspections, the main internal reason was to standardize the documentation procedure of data during inspections (80.0%; 44/55) (Fig. 2A). This reason was respectively followed by the reasons to ensure that all data is available to prepare inspections (69,1%; 38/55) and avoid double work for officers during inspection (54,5%; 30/55). On the other hand, the two internal reasons that most CAs totally disagreed with were to ensure that official controls are free from any conflict of interest (21.8%; 12/55) and check the control performance of officers (20.0%; 11/55). Open answers provided by CAs included the additional three reasons: to obtain and process reliable control data, update data of the FBOs and improve the data reporting to EU institutions like the European Commission or the European Food Safety Authority (EFSA).

With respect to the external reasons, more than half of the CAs totally agreed with the statement to technologically modernize the public administration (54.5%, 30/55), continued by to respond to the FBOs' interests of having access to inspections' data or results (52.7%; 29/55) (Fig. 2B). The two external reasons less totally agreed were to respond to public policies (30.9%; 17/55) and achieve the United Nations' (UN) 2030 Agenda Sustainable Development Goals (SDGs) (10.9%; 6/55).

3.3. Results of using a digital environment during inspections

Of the CAs, 70.9% (39/55) totally agreed that the use of a digital environment internally resulted in the reduction of paper use during inspections, followed by the standardization of the collection of data during inspections (69.1%; 38/55) (Fig. 2C). A total of 51 (92.7%) CAs somewhat or totally agreed that improved communication and data exchange with FBOs was a result of using a digital environment during

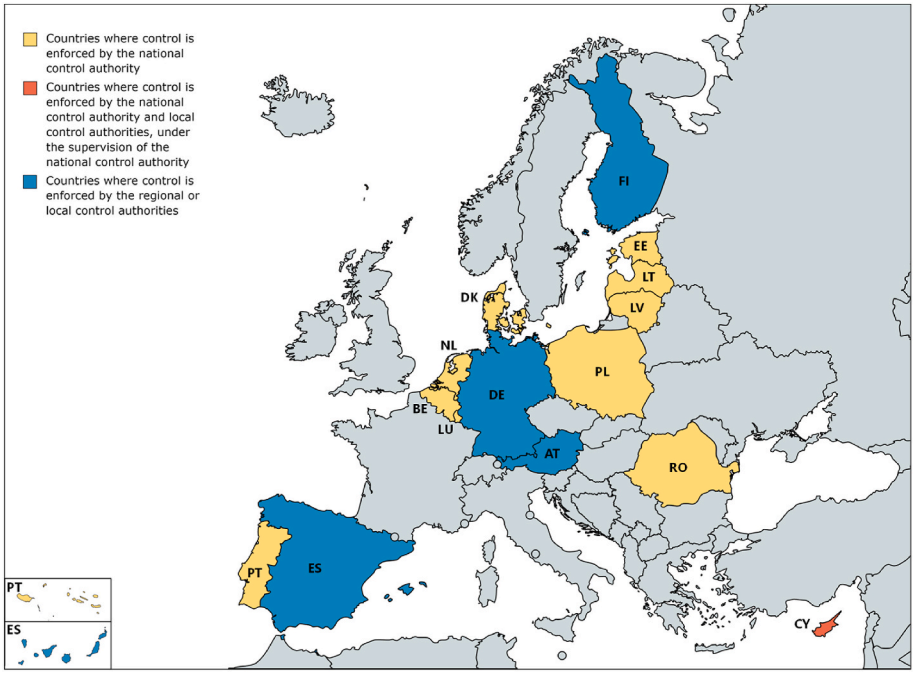

Fig. 1. Participating countries (n = 15). The map shows the participating EU countries classified depending on which administrative level official food safety control inspections are enforced at the retail level. Austria (AT), Belgium (BE), Cyprus (CY), Denmark (DK), Estonia (EE), Finland (FI), Germany (DE), Lithuania (LT), Latvia (LV), Luxembourg (LU), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO) and Spain (ES). Country boundaries are from MAPCHART (https://www.mapchart.net/).

inspections. The internal results most totally disagreed with were ensuring that official controls are free from any conflict of interest (23.6%; 13/55), continued by checking the officers' performance (18.2%; 10/55) and publishing inspections' data or results (18.2%; 10/55).

The external results most totally agreed by CAs were the technological modernization of the public administration (63.6%; 35/55) and giving response to the FBOs' interest of having access to inspections' results and data (60.0%; 33/55) (Fig. 2D). Achieving the UN's 2030 Agenda SDGs (21.8%; 12/55) and responding to public policies (29.1%; 16/55) were the two less totally agreed external reasons.

3.4. Inspection processes carried out through a digital environment during inspections

Of the inspection processes conducted through a digital environment during inspections by CAs, having access to inspection reports of past inspections was the most indicated process by the great majority of CAs (92.7%; 51/55), followed by automatic generation of digital inspection reports based on template documents (90.9%; 50/55) (Fig. 3A). The two processes less and equally indicated (47.3%; 26/55) were automatically establishing the enforcement measures imposed on FBOs according to the non-compliances detected and collecting non-compliances in a systematic way through checklists, results that were similar to the number of CAs that conduct those processes but not through a digital environment, 41.8% (23/55) and 38.2% (21/55), respectively.

CAs when asked about which processes were carried out through a digital environment after inspections, all CAs (55/55) indicated the storage of inspection reports in digital format (Fig. 3B). The second process most indicated was the reporting of annual official control and sampling data to the national authority or the European Commission and EFSA (80.0%; 44/55). The processes less carried out through a digital environment were to obtain indicators to monitor inspection performance (50.9%; 28/55) and publication of inspection results and data, and documents about the inspection system on the Internet (inspection checklists, procedures or organization) (56.4%; 31/55). Of the CAs using a digital environment, 38.2% (21/55) and 30.9% (17/55) did not publish data and results about inspections on the Internet or documents about the inspection system at all.

3.5. Development and implementation process of a digital environment during inspections

CAs when asked which agents participated in the development and implementation process (Table 1), 90.9% (50/55) of CAs reported internal personnel. Further to this, a smaller proportion of CAs also involved external personnel (67.3%; 37/55). During this process, 45.5% (25/55) of the CAs ranked the involvement of management staff as "low" and 43.6% (24/55) as "high". On the other hand, the majority of CAs considered the involvement of officers as "high" (70.9%; 39/55) as well as their engagement (67.3%; 37/55) and motivation (63.6%; 35/55). Most CAs indicated training workshops (74.5%; 41/55) and distribution of educational material (guides, videos or e-learning modules) (69.1%; 38/55) as the most conducted training activities to prepare officers to use a digital environment during inspections.

3.6. Reasons for not using a digital environment during inspections

From the 33 CAs that did not use a digital environment during inspections, 39.4% (13/33) equally and totally agreed that such an environment was not used due to lack of budget and technological constraints, followed by lack or shortage of information technology personnel (33.3%; 11/33) (Fig. 4). More than half of the CAs totally and somewhat disagreed that not considering using a digital environment during inspections (69.7%; 23/33), reluctant FBOs (54.5%; 18/33) or resistance to change the inspection procedure amongst staff of CAs (54.5%; 18/33) were reasons for not using a digital environment.

CAs expanded their answers through free-text comments by adding further reasons for not using such an environment during inspections. Those reasons included the coexistence of different and non-interoperable digital systems in the public administration, lack of Internet connection at the food premises and because a computer-intended app was used with tablets and smartphones, which led to a very complex process. Further to this, one CA indicated fear of using a digital environment because it would make the inspection process more transparent.

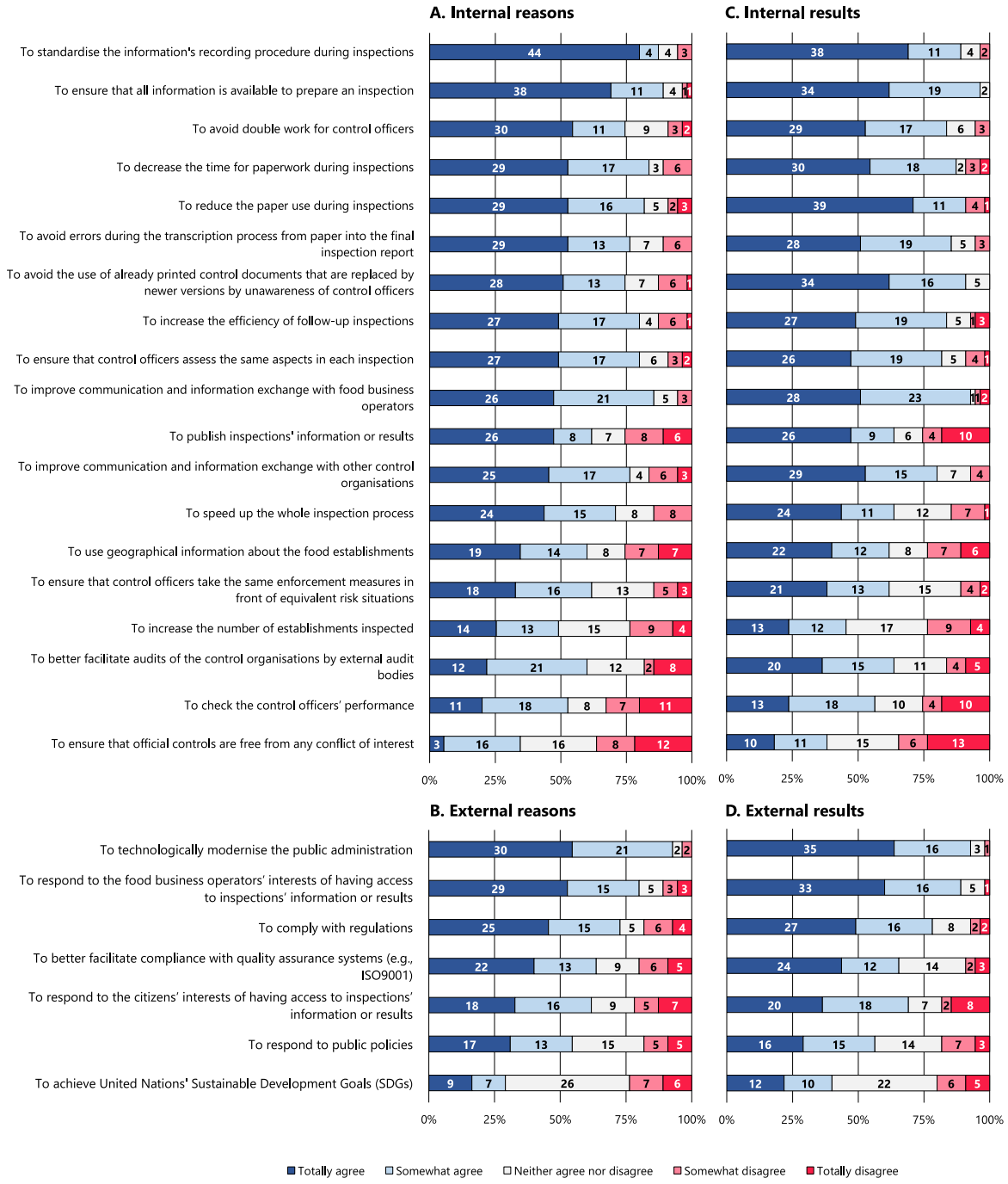

Fig. 2. Internal reasons (A) (reasons that come from within the competent authorities) and external reasons (B) (reasons that come from outside the competent authorities) of competent authorities for using a digital environment during official food safety control inspections, and internal results (C) (results that impact within the competent authorities) and external results (D) (results that impact outside the competent authorities) of using such an environment (n = 55).

4. Discussion

This multi-country survey study is the first research to our knowledge exploring the use of a digital environment during inspections in countries of the EU. This study underlines that many CAs in the EU countries already use a digital environment to support inspections at retail establishments. Moreover, the majority of CAs had similar reasons for and results derived from using this environment related to consistency of official control. In the same line, almost all CAs that use a digital environment carry out the same processes during inspections through such an environment. The results of this research provide interesting insights about the utility of digital technologies in official control, showing their possibilities and benefits. Moreover, these results might help policy-and decision-makers of CAs that do not use a digital environment during inspection to implement such an environment and improve the current official food control system.

Our results show that the majority of CAs use a digital environment to switch from paper- to digital-based systems in order to standardize the process to collect and record data during inspections. This context contributes to minimizing possible inconsistencies related to inspection documentation, for instance between officers or subordinate local and regional units. In addition to this, using a digital environment benefits CAs by ensuring that the officers assess the same aspects in each inspection (Kahneman et al., 2021). In the same line, in the field of

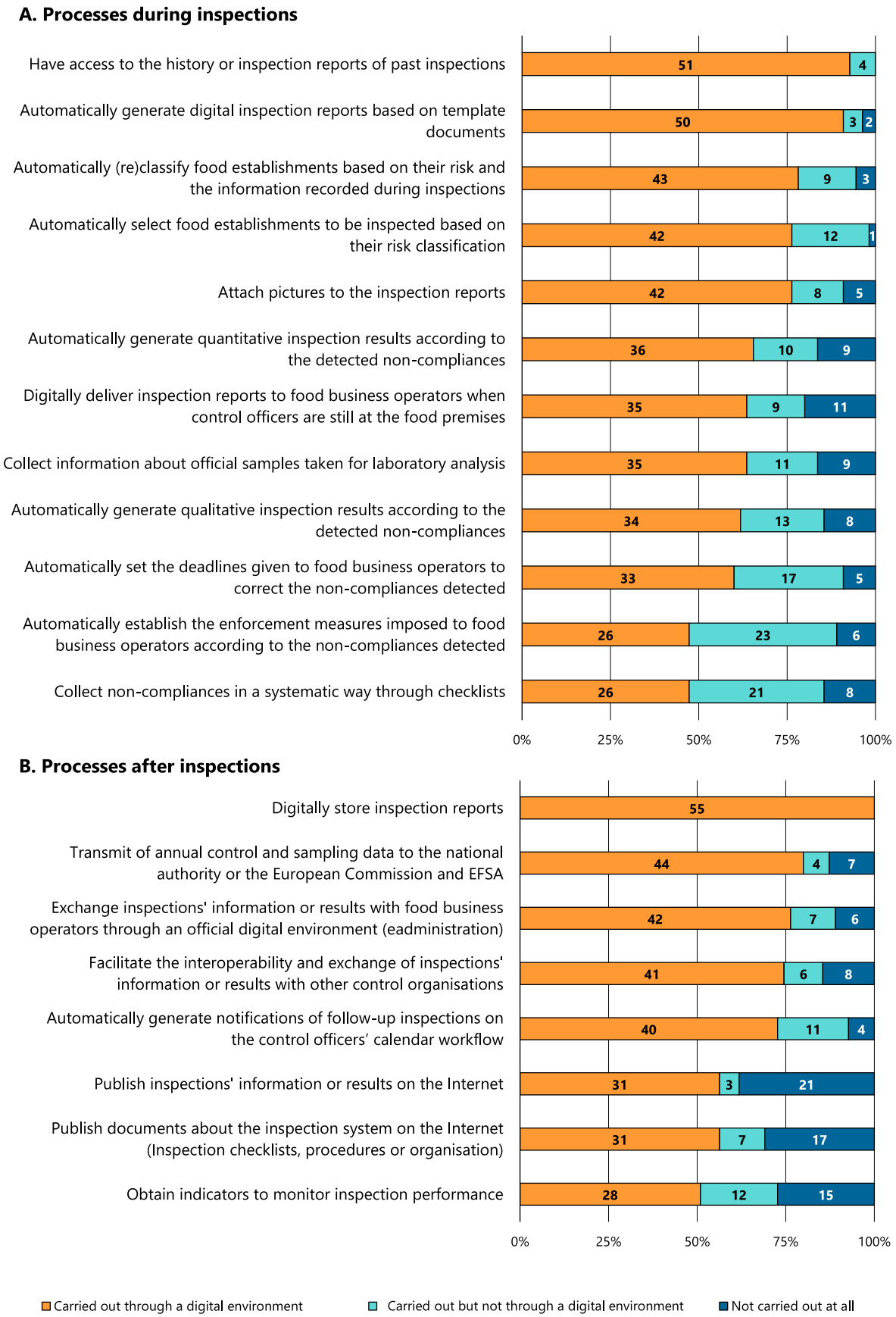

Fig. 3. Official food safety control inspection processes carried out through a digital environment during inspections (A) and after inspections (B) by competent authorities that used a digital environment during inspections (n = 55).

Table 1
Aspects asked to competent authorities (CAs) about the development and implementation process of a digital environment during inspections (n = 55). Percentages are calculated based on the total number of CAs that used a digital environment during inspections.

Aspects asked to competent authorities	n (%)
Agents involved in the development and implementation process of a digital environment[a]	
Internal personnel	50 (90.9)
External personnel (consultants, specialists, etc.)	37 (67.3)
Organizations of food business operators	7 (12.7)
Other	5 (9.1)
Not sure	2 (3.6)
Organizations of consumers	1 (1.8)
Involvement of management staff	
High	24 (43.6)
Low	25 (45.5)
Not sure	5 (9.1)
No participation	1 (1.8)
Involvement of control officers	
High	39 (70.9)
Low	14 (25.5)
Not sure	1 (1.8)
No participation	1 (1.8)
Engagement of control officers	
High	37 (67.3)
Low	8 (14.5)
Not sure	10 (18.2)
Motivation of control officers	
High	35 (63.6)
Low	10 (18.2)
Not sure	10 (18.2)
Training activities aimed to train control officers in using a digital environment[a]	
Workshops	41 (74.5)
Distribution of educational material (guides, videos or e-learning modules)	38 (69.1)
Simulation of inspection situations from the office	31 (56.4)
Informal feedback from peers and managers	28 (50.9)
Focus groups	16 (29.1)
Support by experts during inspections	9 (16.4)
No training	1 (1.8)
Other	1 (1.8)
Not sure	0 (0.0)

[a] Competent authorities could record more than one answer.

healthcare, digital technologies are also implemented to standardize this process across governmental agencies (Labrique et al., 2013). In countries and regions where official control is decentralized, implementing harmonized digital systems to collect inspection data may help to carry out this activity systematically under the same criteria and allow valid further comparison and monitor of official control performance among CAs.

Using digital technologies for data documentation also results in decreasing the time for paperwork during and after inspections particularly when writing the inspection reports or transcribing the inspection findings from paper notes to the final report. Further to this, recording data directly in electronic format during inspections helps to avoid possible misunderstanding of officers' handwriting by FBOs and increases the quality of the data registered (Alban et al., 2022). The use of digital tools to collect and register data from the field avoids duplication and redundancy compared to manual work registration and leads to a process less prone to involuntary human errors (Nabais et al., 2022). There is evidence that switching from manual- to digital-based documentation of patients' data in healthcare facilities decreased the errors linked to this process by more than half (Gearing et al., 2006).

According to our results, a digital environment is also employed to automatically generate digital inspection reports based on template documents at inspections, share the reports with FBOs when inspectors are still at the food premises, store in servers and have access to their content from the field. According to Nabais et al. (2022), using a digital tool to collect food samples' data helps to make the report processes more efficient. Creation of digital reports following template documents contributes to documenting inspections and informing FBOs systematically and thus improving the consistency of this process. Additionally, having digital instead of paper reports could prevent the loss or misplacement of inspection reports that may occur with paper forms. Switching from paper to electronic documentation of inspections allows, not just storing data in digital servers and creating electronic records, but also to break the physical boundaries and additionally share and transmit them in real time, have remote access to and update their content directly from the field, and not merely through fixed desktop computers (Labrique et al., 2013; Oppong et al., 2021). Therefore, in this context, as indicated by many CAs, all data is available to prepare inspections and accessible from the inspection site. For example, at the time officers are inspecting, they can access the history or inspection reports of previous inspections.

In this study, almost all CAs transmit and exchange inspection and sample data between their counterparts, FBOs, the European Commission or the EFSA through a digital environment after inspection. We assume that having inspection data stored in electronic format facilitates a direct interoperability between agents, avoiding time-consuming tasks such as transcription of inspection data from paper inspection reports to a digital dataset, which could also be the object of transcription errors. In contrast, despite having inspection data stored in digital format, more than one-third (38.2%) of the CAs do not publish inspection data and results on the Internet at all. One possible reason for this situation may be attributable to fear or resistance to publish inspection data and not just to technological limitations. On the other hand, for several CAs, publication of inspections' data or results was not a reason for using a digital environment. There is evidence that disclosure of inspection reports influences the number of food-borne outbreaks (Kim et al., 2022). The use of a digital environment represents a good prerequisite for publishing inspection results in a consistent way, which should be seriously considered among those CAs not yet publishing results.

Monitoring inspection performance is an important task for CAs to

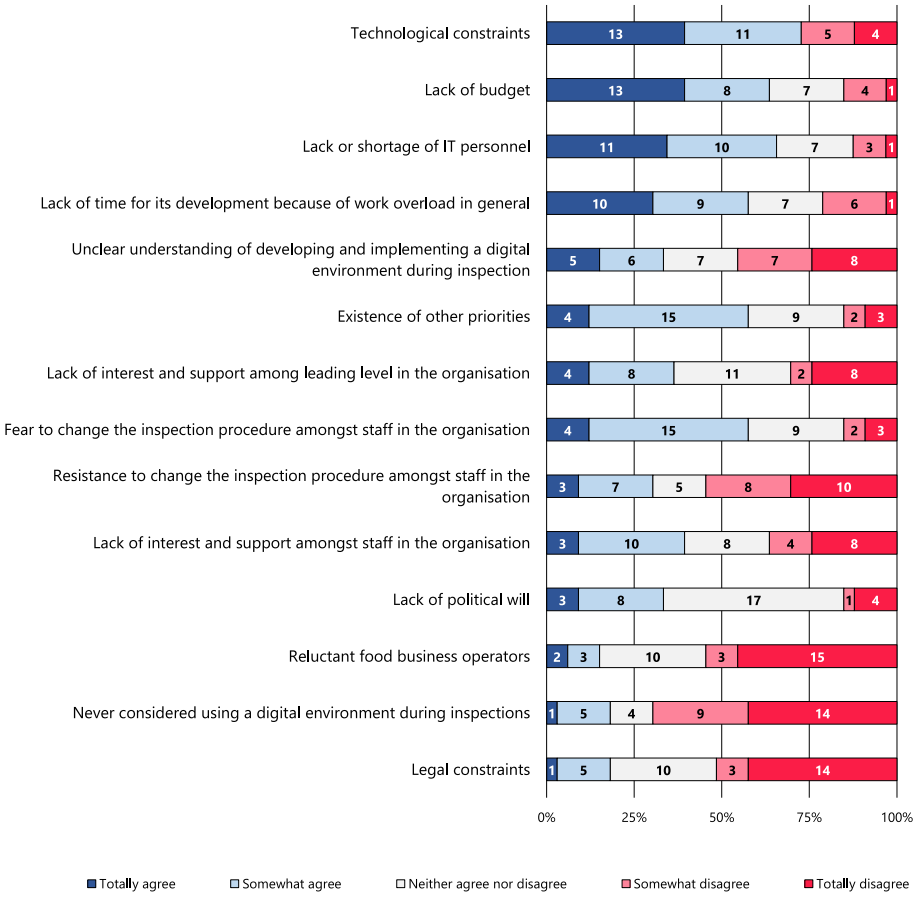

Fig. 4. Reasons for not using a digital environment during official food safety control inspections by competent authorities that did not use such an environment during inspections (n = 33).

measure the results of official control activities, analyze whether the targets are achieved or the effectiveness of inspections. While there is a big proportion of CAs that do not obtain indicators to monitor inspection performance at all, only 50.9% of the CAs use a digital environment after inspections to obtain indicators. In that sense, we think that there is a need to integrate digital technologies and use their potential, in this case and in line with Labrique et al. (2013), to process, analyze and identify patterns from big sets of data.

It is important to note that the possibilities of digital technologies go beyond switching from paper to digital forms to record, store and process data. In that regard, the benefits given by using algorithm- and rule-based instructions to automate processes and decision-making can potentially represent a paradigm shift in official control. Based on Kahneman et al. (2021), the use of algorithms as well as machine learning technologies reduce systematic deviation and random scatter in human judgment and achieve the so-called 'decision hygiene'. This term refers to making judgments free of noise, which is the unpredictable human unwanted variability affecting the consistency and reliability of decisions-making. There are already cases of using digital technologies to support frontline health workers to prioritize high-risk patients, reduce clinical errors or enforce workers to follow defined guidelines (Labrique et al., 2013). Although digital technologies are becoming support tools to help professionals on a daily basis, the design and construction of the rules and pre-established instructions depend on human experiences and knowledge (Davenport & Kalakota, 2019). Automatizing processes during inspections through digital decision support tools to officers can contribute to standardize inspection processes and decision-making towards improving consistency of official control.

Based on our results, most of the CAs automate processes related to the management of official control. Those processes include the risk classification of food establishments, the selection of establishments to inspect according to their classification and the generation of notifications of follow-up inspections. Differences in applying the internal criteria of CAs for those processes would generate inconsistencies for example of how inspections for certain establishments are prioritized over the rest of establishments or frequencies of follow-up inspections. For instance, electronic work planning and scheduling tools are employed to support healthcare workers to actively remind upcoming events and prioritize visits (Labrique et al., 2013). By automatizing those processes, the responsibility to ensure that official control is performed consistently according to the internal guidelines relies on the criteria pre-established at the digital environment to automate the processes and not on officers' criteria. Likewise, this context may potentially help to prioritize risk-based planning of inspection visits and resource allocation. In view to automate processes according to a harmonized criterion, preliminary work has been developed in the EU to implement digital tools to support officers to automatically classify food when sampling according to the FoodEx2 classification (Nabais et al., 2022).

Other inspection processes also automatized by most CAs are related to generating inspection results based on the non-compliances detected during inspections. Quantitative inspection approaches can be linked to numerical grading schemes associated with prescribed enforcement actions (Borraz et al., 2022; Kettunen et al., 2018; Yapp & Fairman, 2006). Whilst most concerns about how official control is delivered are related to the regulatory enforcement consistency, the selection of enforcement measures through rule-based instructions according to the inspection results could be automatized and consistency in this regard be improved. Automatizing those processes and using the digital environment as a decision support tool could minimize inconsistencies coming

from individual-level factors. Those inconsistencies are related to officers' experiences, views or understanding of the law and may lead to different economic burden for FBOs, personable relationships between officers and FBOs or higher tolerance and flexibility with specific FBOs (Buckley, 2015; Isaacs et al., 1999). In the healthcare sector, where diagnoses and decisions are mostly based on medical professionals' experience, digital technologies are used to be more accurate in the diagnosis and treatment decision (Basile et al., 2022; Davenport & Kalakota, 2019). This is the case even in official meat control in slaughter and game handling (Alban et al., 2022). In this sense, as a result of systematizing processes such as the selection of enforcement measures in official control, the response of officers in front of equivalent risk situations should be consistent between them. Despite these benefits of using digital technologies, many CAs do not carry out this process through a digital environment, alongside setting the time limit given to FBOs to correct the non-compliances detected during inspections.

Sociotechnical System Design Theory claims that organizations are structured in two parts: the technological and the social (Mohr & van Amelsvoort, 2016). While the technological part relates to production tasks and technology, the social part relates to the human tasks, work and experiences of the personnel. Developing and implementing a digital environment during inspections entails changes over both parts of CAs and particularly to the social part, which need to be addressed in order to maximize the profit of digital technologies and ensure their long-lasting use. In that sense, a participative approach of organizations' personnel is key during this process (Govers & van Amelsvoort, 2019). According to our results, almost all CAs surveyed involved internal personnel in the development and implementation process of a digital environment during inspections and to a lesser extent, external personnel such as consultants or specialists. Among the internal personnel, officers were more involved than management staff. Personnel's motivation towards using digital technologies is also critical for the success of the implemented technology (Konttila et al., 2019). Based on our results, the motivation of officers was rated as high by almost two third parts of the answering CAs.

Alongside the participation of personnel during the development and implementation process of new technologies, the competencies of officers in using those technologies are also important. Lack of competencies in using new working methods negatively influence the efficiency of organizations' workflow (Ross et al., 2016). In that sense, the great majority of CAs trained their officers to use a digital environment. The most conducted training activities were workshops, distribution of educational material among officers (guides, videos or e-learning modules) and simulation of inspection situations from the office. Although not being addressed in this study, it is important to highlight that there is another factor that influences the successful implementation and use of a digital environment, which is the design of the digital environment itself (Nielsen & Sahay, 2022).

According to our results, the most indicated limitations for not using a digital environment during inspections were technological constraints, lack of budget and lack or shortage of information technology personnel. Those results are consistent with an earlier study in which Meijer (2015) identified the same reasons and, among other researchers, defined them as structural barriers (Eynon & Dutton, 2007; Ofoeda et al., 2018). According to Zhe Jin and Lee (2014), digital solutions are difficult to implement because of limited resources and rigid schemes of the administration. In our study, a few CAs do not use a digital environment during inspection because of legal constraints. Although the small proportion of CAs that see this aspect as a barrier, in our view, it is very much important to identify this hurdle since it could limit the use of a digital environment during inspections. Further to the structural barriers, another important factor to consider are the cultural barriers, which are those related to the values within organizations (Meijer, 2015). Our results showed that those barriers, which include fear, resistance or reluctance, did not weigh as much as the structural barriers for not using a digital environment during inspections. These results might help CAs when planning to develop and implement a digital environment to better identify, understand and address its hurdles.

This study has strengths and limitations. One of its strengths is the number of experts from different EU countries that validated the questionnaire. This aspect enriched the initial version of the questionnaire by including domestic characteristics and views of each country as well as questions related to the use of a digital environment during inspections, making the questionnaire more comprehensive and inclusive. Another strength is that this study encompasses CAs from different EU countries that enforce official control from different administrative levels, representing CAs from national, regional to local levels, according to the distribution of official control competences of each territory. On the other hand, although having reached CAs from 15 EU countries, one limitation is that not all EU countries participated in the study. This necessitates extra care when making inferences on the study results. Additionally, regarding those countries that participated in the study where official control is decentralized, not all CAs were reached. Therefore, our findings may not represent the whole EU picture. We assume that differences exist between CAs in terms of type (national, regional or local), size, geographical location, number of establishments under their responsibility, needs or budget allocation. Although being variables that could affect the use of a digital environment, another limitation is that those aspects were not considered in our analysis. One additional limitation that the authors suspect is that the subject of this research raised more motivation to participate in this study to those CAs that are already using a digital environment or developing this environment, compared to those that are not using such an environment. However, several CAs not using a digital environment during inspections answered the questionnaire providing insights about the reasons for not using this environment during inspections.

One important aspect not included in this study was the question related to cybersecurity in the digital ecosystem. Several cyber-attacks occurred during the past two decades to both private and public sectors causing important financial costs (Federal Bureau of Investigation, 2019; Kayan et al., 2022). The motivations behind a cybercrime can range from financial, revenge, recreation to curiosity (Chng et al., 2022). The use of digital technologies helps to efficiently exchange data through the Internet between actors and store data in cloud servers while increasing opportunities for hackers to find system weaknesses. Hence, cybersecurity should also be considered when designing and implementing a digital environment. Increased technological dependence also creates larger attack surfaces (Victor Kardeby & Anna Rydberg, Swedish National Food Agency, conference communication, Finnish Veterinary Congress, November 2, 2022). A question that should be raised and tackled is whether hacking represents a reason for CAs to not use digital technologies and rely on a digital ecosystem.

If digital technologies are implemented to replace some time-consuming tasks carried out by officers, such as transcribing the written inspection report to a digital database, this new situation may relieve some of the pressure derived from shortage of personnel. Thus, these personnel may be able to undertake further tasks potentially leading in saving costs (European Union, 2019). Although this is an important aspect to consider for policy- and decision-makers of CAs when implementing digital technologies, the impact of using such technologies on the costs of official control activities was not considered in this study. Acknowledging that this study underlines that lack of budget represents an obstacle for several CAs to implement a digital environment, metrics related to the conceivably cost-saving impact of digital technologies should be addressed. Further to this, no attempt was made to assess the impact of using digital technologies on the effectiveness of official control. Acknowledging the importance of measuring this principle of food control, in our opinion it should be carried out through analyzing for example inspection results, detection of non-compliances during inspections or correction of non-compliances by the FBOs after planned or follow-up inspections.

In conclusion, the digital era has reached official food safety control inspections at the retail level. Although not all responding CAs are using a digital environment during inspections, a notable number of CAs are already using such an environment to support inspections primarily to digitalize the process of data documentation. We consider, however, that the potential and opportunities of digital technologies should be more used as decision support tools, with a view to standardize the delivery of inspections and thus increase their consistency, thereby implementing better decision hygiene in official control.

The results presented here can be used for CAs in the process of developing and implementing a digital environment as well as to find solutions to limitations faced by the traditional inspection systems at the retail level of the food chain through digital technologies. Acknowledging the limitations of the present research, this study represents a baseline to continue inquiring into the use of digital technologies in official control. Future research lines should focus on knowing and understanding how the digital environments are designed and protected as well as the impacts of using such environments over the end users, the officers and FBOs, and the effectiveness and consistency of official control.

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CRediT authorship contribution statement

Eduard Grau-Noguer: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Funding acquisition. **Remo Suppi:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Maica Rodríguez-Sanz:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Jordi Serratosa:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Assun Bolao:** Conceptualization, Methodology, Writing – review & editing. **Janne Lundén:** Supervision, Writing – review & editing. **Patrick Hau:** Writing – review & editing. **Filipa Melo de Vasconcelos:** Writing – review & editing. **Riikka Åberg:** Writing – review & editing. **Cecilia Blomgren:** Writing – review & editing. **Michel Lambert:** Writing – review & editing. **Keidi Leppik:** Writing – review & editing. **Ivar Vågsholm:** Writing – review & editing. **Arja Helena Kautto:** Writing – review & editing. **Johannes Lueckl:** Writing – review & editing. **Sarah Abeln-Richter:** Writing – review & editing. **Rolf Kamphausen:** Writing – review & editing. **Erno Bammens:** Writing – review & editing. **Filippos Georgiades:** Writing – review & editing. **Jānis Altenburgs:** Writing – review & editing. **Samuel Portaña:** Conceptualization, Methodology, Supervision, Writing – review & editing, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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