Journal of Food Protection 87 (2024) 100196

Contents lists available at ScienceDirect

Journal of Food Protection

journal homepage: www.elsevier.com/locate/jfp

Research Paper

Official Control in Slaughter and Game Handling: Expectations and Prerequisites for Implementation of Remote Meat Inspection in Sweden

Agnieszka D. Hunka [1,*], Emanuela Vanacore [1], Ingrid Medin [2], Ermela Gjona [1], Arja Helena Kautto [2,3]

[1] RISE Research Institutes of Sweden AB, Sven Hultins plats 5, 41258 Gothenburg, Sweden
[2] Control Unit Southern Sweden, Control Department, Swedish Food Agency, Dag Hammarsköldsväg 56 C, 752 37 Uppsala, Sweden
[3] Department of Biomedicine and Veterinary Public Health, Swedish University of Agricultural Sciences, Ultuna, Ulls väg, Ultuna, 750 09 Uppsala, Sweden

ARTICLE INFO

Keywords:
Ante-mortem
Attitudes
Food control
Post-mortem
Remote audit

ABSTRACT

Remote meat inspection is currently not permitted under the European Union food control legislation. However, the environmental impact of travelling to and from abattoirs and increasing shortages of qualified veterinary staff make remote controls a potential future scenario. This paper reports the results of a qualitative study conducted with a sample of nineteen official veterinarians and food business operators in Sweden. We investigated attitudes, perceived risks, and prerequisites for remote meat controls in semi-structured interviews.

Results indicate both positive attitudes towards remote meat inspection, and concerns related to technical challenges, reliability and security of data transfer, and possibilities of manipulation of the remote system. Respondents also noted both negative effects, such as physical hurdles for good control, and positive impacts on animal welfare, such as shortened waiting times for slaughter. Considering the current regulatory framework, only 21% of the respondents have had any prior experience with (pilot) remote meat inspections and the additional 11% carried out remote inspections of Food Chain Information documents. Nevertheless, all participants, including the majority without any prior experience in remote inspections, assumed that remote inspections would be done via video streaming. The optimal setting for a remote meat inspection, according to our respondents, seems to be a combination of cameras at fixed locations with body cameras worn by assisting abattoir personnel. Overall, remote meat inspections are possible to introduce but not without significant legal and technical adaptations as well as definition of the conditions for this type of control flexibility.

Consistency and effectiveness of official controls are important factors along the whole food chain (European Parliament and the European Council, 2017; FAO CAC/GL 82-2013, 2013). Tasks of competent authorities include official controls of food business operators (FBOs) with regard to activities, including the handling of animals, equipment, means of transport, premises, and other places under their control and their surroundings related documentation on animals and goods at any stage of production, processing, distribution, and use. Competent authorities also perform official controls on animals and goods at any stage of production, processing, distribution, and use.

Official meat inspection (MI) is a mandatory key control procedure which aims to assess if the meat is fit for human consumption in general and to address a number of specific hazards, such as foodborne pathogens or chemical contaminants (EFSA, 2012, 2013). A health marking is applied as a mark on the carcass after the official MI attests that the meat is fit for human consumption (European Parliament and the European Council, 2017).

MI at abattoirs consists of two parts. Livestock (domestic animals and farmed game) presented for slaughter by the FBO must undergo ante mortem inspection (AMI) before stunning, bleeding, and slaughter and, subsequently, post-mortem inspection (PMI) of carcass and offal after slaughter. Although AMI is usually taken to represent the examination immediately before slaughter, its full scope embraces pre-slaughter handling and extends to the husbandry of the animal on the farm (European Commission, 2019). The definition of AMI is stated in the European Union (EU) Regulation 2017/625 (European Parliament and the European Council, 2017) as the verification, prior to slaughtering activities, of human and animal health and animal welfare requirements, including, where appropriate, the clinical examination of each individual animal, and the verification of the food chain information (European Parliament and the European Council, 2004). The EU Regulation 2019/624 states that AMI is conducted at abattoirs; however, derogations are in place for AMI in certain cases like in cases of emergency slaughter of a limited number of domesticated animals

* Corresponding author.

https://doi.org/10.1016/j.jfp.2023.100196
Received 19 July 2023; Accepted 15 November 2023
Available online 20 November 2023

per occasion or slaughter at the place of rearing of farmed game (European Commission, 2019).

Both AMI and PMI are viewed as important measures to ensure consistency in food safety, animal welfare, and animal health control, and Official Veterinarians' (OVs) role is considered crucial for a successful MI (Luukkanen et al., 2015), particularly in fighting against emerging and reemerging diseases such as bovine tuberculosis (Blaha, 2012; Stärk et al., 2014). Consequently, AMI of domesticated and farmed animals is strictly regulated as an activity done in person by OV while official auxiliary (OA) can do some practical activities under the supervision or responsibility of the OV (European Parliament and the European Council, 2017). OVs are veterinarians recognised and appointed by competent authorities, in Sweden by the Swedish Food Agency (SFA). OAs in Sweden are not veterinarians but have practical working experience in abattoirs. Their role is defined in the EU Regulation 2017/625. OAs can perform some PMI tasks, but the results of the inspection always remain the responsibility of OVs.

MI is performed according to protocols depending on the animal types and type of rearing within the framework of the EU legislation. Stärk et al. (2014) highlighted a substantial lack of suitable and accessible published data on the frequency of occurrence of many diseases and conditions affecting food animals across the EU. In Sweden, MI is regulated under the transposed EU Regulation 2019/624 (European Commission, 2019). Currently, the need to provide OVs with more detailed food chain information (FCI), as outlined in the EU Regulation 853/2004 (2004), is considered a weak link in the MI process. In particular, the need for a better data information system has been pointed out by several scholars. Felin et al. (2016), for instance, argued for the need to develop guidelines for uniform food chain information reporting.

The COVID-19 pandemic sparked the debate on feasibility and cost-effectiveness of remote audits in the food production sector. Remote Visual Inspection (RVI) or Remote Digital Video Inspection (RDVI) is a form of visual inspection which employs visual aids such as video technology to allow an inspector to observe objects, materials, and individuals from a distance (Mix, 2005). Remote audits have been tested in several countries and showed promise, especially in combination with site visits (Deuss & Honey, 2023). Although the use of digital aids has rarely been considered in MI literature to date, some scholars have tested video technology to advance or improve MI procedures. Almqvist et al. (2021) investigated the reliability of remote PMI of pigs using augmented-reality live-stream video software and concluded that remote PMI appears to constitute a viable alternative for on-site PMI of pigs, given a sufficiently standardised method of PMI and sufficient inspection times. Kautto and Comin (2023) reported the results of a pilot study comparing remote and on-site AMI. An overall agreement of 99.1% between both types of control was recorded. The total number of inspected animals was 1177, with the total number of non-compliance cases at 1.8%. Interestingly, remote OVs reported more non-compliance incidents than on-site OVs.

The uptake of Remote Inspection techniques outside the food production sector has dramatically increased over the last few years. Remote inspections are conducted in nuclear energy facilities (Kershaw et al., 2013), within the construction sector as structural surveys of inaccessible structures (Ribeiro et al., 2020) and in the maritime sector (Alexandropoulou et al., 2021). Remote audits have also been tested in the agricultural sector to tackle challenges of traditional auditing of agricultural commodities, including lack of human resources (Mahmud et al., 2023).

However, some epistemic uncertainty exists around possibilities and willingness to conduct AMI and PMI remotely (Almqvist et al., 2021; Deuss & Honey, 2023). The uncertainty around adoption of new technologies can usually be addressed and – to a certain extent – reduced with reliability analyses (Breneman et al., 2022; Michelsen, 1998). However, the prevalence of both animals not fit for slaughter and carcasses with non-compliant findings is generally low in Sweden (Almqvist et al., 2021, Kautto & Comin, 2023), indicating a good state of the population of production animals. At the same time, a larger sample is needed to assess reliability with a standard set of epidemiological methods. Moreover, it has been repeatedly demonstrated in psychological studies that people often associate new methods with high risk and in turn, results often in uncertainty avoidance and a tendency to rely on business-as-usual solutions (De Meulenaer et al., 2018; Eiser et al., 2002; Satterfield et al., 2009).

The need to produce food and audit the food chain under the restrictions of the COVID-19 pandemic started the debate about remote food audits at the international level, opening up potential avenues for lowering the environmental and economic impact of audit-related travels (Deuss & Honey, 2023). The implementation of remote MI measures, both in AMI of animals prior to slaughter, and PMI of carcasses and offal has also garnered interest of SFA. Since 2018, SFA has strived for evidence for the possibility to create a new model for remote meat inspection flexibility in EU legislation (Kautto, 2022).

The purpose of this study is to systematically investigate attitudes, expectations, and prerequisites to implement remote control methods in AMI and PMI at low-capacity abattoirs and game-handling establishments. These small establishments, due to their often-remote locations and relatively low output, have been identified as suitable venues for tests and implementation of remote inspections (Kautto & Comin, 2023). This flexibility could mitigate the environmental effects of travel to and from establishments, improve cost-effectiveness, and ensure consistency of MI against shortages of qualified veterinary staff.

Given that remote MI in slaughter and game handling is not accepted under the EU legislation concerning official meat control (European Parliament and the European Council, 2017), studies in this area remain scarce. This paper aims to address this knowledge gap with a systematic study of the following areas:

1. Attitudes of OVs and abattoir management towards remote controls;
2. Perceived risks of and prerequisites for implementing remote AMI and PMI among the aforementioned groups;
3. Perceived impact of remote controls on four aspects:
   a. animal welfare
   b. environmental impact
   c. work efficiency
   d. quality of controls.

Materials and Methods

This paper reports the findings of the first, standalone study of a two-part mixed-method project. The study utilises an in-depth, qualitative analysis of the above-mentioned aspects based on semi-structured interviews. The second part, planned for 2023 is a quantitative, discrete choice experiment which would allow us to evaluate different possible scenarios for remote inspections.

Theoretical underpinning. In this paper, we deliberately decided to apply a theoretical framework that originates in business innovation research to construct the interview questions, namely the Value Proposition Canvas coined by Osterwalder et al. (2015). The reason for this is two-fold. First, the classic technology acceptance research (Davis et al., 1989; Goodhue & Thompson, 1995; Rogers, 1976) rests on the assumptions that users are free to choose the technology and that the adoption rate remains correlated with features of the technology in question, individual user's characteristics, or both. However, OV users are not free to choose in the setting at hand; all MI procedures are regulated by legal frameworks, and any use of remote controls is currently not permitted, hence not available to users. Therefore, a service design approach seems more applicable than any type of technology adoption analysis.

The Value Proposition Canvas framework has been extensively used in research focused on designing new services and products, for

instance in transport (Meng et al., 2020), agriculture (Pokorná et al., 2015), and online service platforms (Belleflamme & Neysen, 2021). The canvas was designed as a tool for enterprises in the development of products and services focused on customers' needs and values. As such, the user of a service/technology is described as the "customer". The canvas comprises two parts – Customer Profile and Value Proposition. The first part, the profile, is simplified into three areas: (1) customer jobs describe the tasks the customer must complete; (2) customer pains describe any adverse outcomes, risks, and obstacles in customer jobs, and (3) gains describe positive outcomes and concrete benefits the customer seeks. The Value Proposition part describes the so-called "gain creators" and "pain relievers" that address the relevant needs identified in the first step. A schematic view of the Value Proposition Canvas is presented in Figure 1. In this paper, we employed the canvas to design interview questions (see Appendix A), which were subsequently reviewed for relevance by two OVs active in MI.

Selection of participants. In March 2022, the SFA compiled a list of OVs who were routinely conducting both AMI and PMI in abattoirs and game-handling establishments, and who expressed interest in taking part in in-depth, semi-structured interviews. The list had contact details of 51 OVs at different locations and positions within the organisation, including managers at all levels. Subsequently, the research team (independent of SFA) employed a purposive sampling procedure (Marshall, 1996) and followed the key informants' approach. The team sampled prospective participants from the aforementioned list ensuring that a variety of locations (North, Middle, and South of Sweden), positions (OVs and managers at all levels), types of establishments OVs were typically working with (small-, medium- and large abattoirs and game-handling establishments), background variables, and place the OVs attained their professional education (Sweden, Europe, other countries) were represented. The interviewing team chose OVs with predefined characteristics from the contact list and invited them via email, describing shortly the project and ensuring that the interviews would be conducted during their worktime, but independently of SFA. If a person declined the invitation, the next person meeting the predefined criteria was contacted. This resulted in 24 interview invitations sent and 14 OVs interviewed. In Sweden, there are approximately 180 OVs working with MI and a further 20 working in the management and supervision of official controls. Thus, the interviewed sample comprised 7% of the total population of Swedish OVs (SOU, 2022:58, 2022).

Subsequently, in November 2022, SFA compiled a list of abattoirs following a predefined set of criteria, namely: low-capacity (less than 1001 livestock units per year) or medium-capacity (1001–10,000 livestock units/year) (European Commission, 2019), from different parts of the country, and slaughtering both domestic animals, reindeer (classified as farmed game), and/or handling of wild game. Following the same sampling procedure, the research team contacted eight enterprises. Interviews with the FBO group were conducted in February until March 2023, by the same interviewing team. Five establishments responded positively and participated. There are approx. 170 abattoirs and game-handling establishments in Sweden that fulfil the low-capacity criteria, resulting in the sample size of 3% of the total number of abattoirs.

Although the sample size negatively affects the possibility to maintain the full anonymity of participants, we followed the same interviewing procedure, ensuring that the interviews were anonymised and only accessible by the research team not affiliated with SFA. Table 1 presents a more detailed overview of participants (group, location, and type of responsibilities).

Data collection procedure. All interviews were conducted by the same research team online (via Microsoft Teams) and recorded, and transcribed verbatim with the participants' permission. Informed consent, including consent for recording, was obtained verbally. Participants were also informed that the recordings and transcripts of the interviews would be only accessed by researchers not affiliated with SFA and that their responses would be further aggregated and fully anonymised.

In total, 19 semi-structured interviews were conducted. They comprised four open themes with sub-questions (Appendix A). The themes were identical for both groups (OVs and representatives of abattoirs) and only modified to the extent that reflected the participant's role (e.g., "you" was replaced with "your company"). An overarching subject of our study were the general procedures of AMI and PMI and the possibility for conducting these controls remotely. Therefore, the interviews were centred on AMI and PMI strengths and weaknesses, existing procedures and routines, possibilities to implement innovative solutions in daily work, and separately, a discussion on remote work in general and on remote controls.

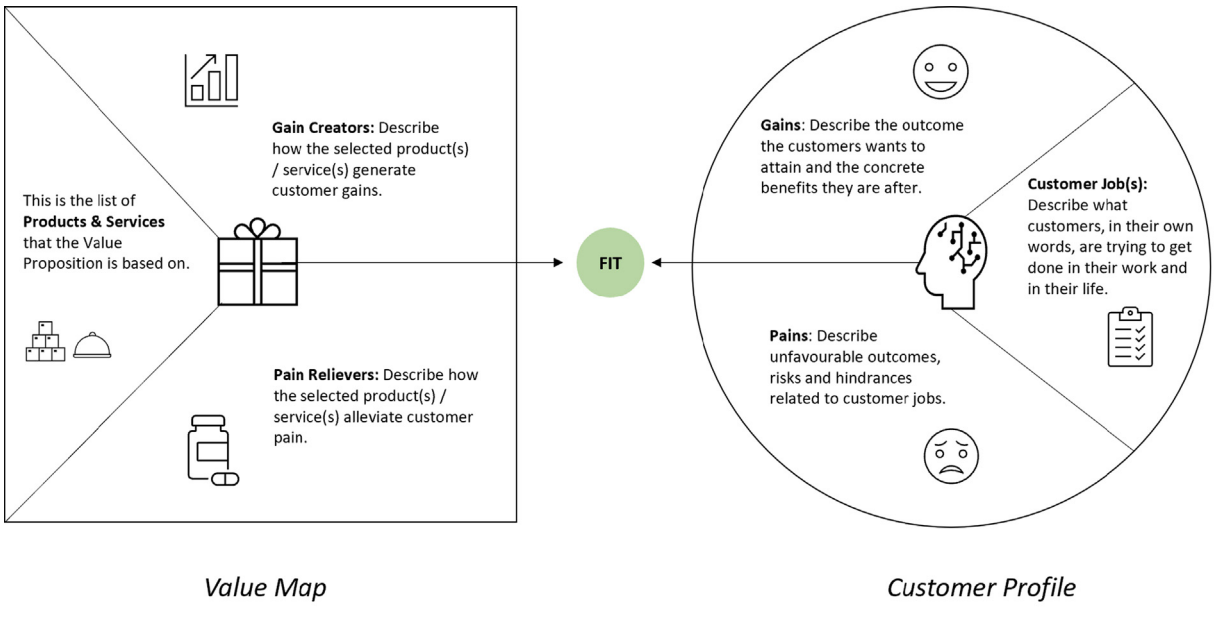

Figure 1. The value proposition canvas (Source: Osterwalder et al. (2015)).

Table 1
Overview of the study participants N = 19

	North	Middle	South
OV	3	4	3
Manager with MI experience and/or responsibilities	2	1	1
FBO	2	1	2
Total participants	7	6	6

Overview of participants (N = 19).

Data analysis. Recorded interviews were automatically transcribed through Microsoft Teams set to Swedish. In the next step, the interviews were first anonymised: all identifying information was removed leaving only the participant number corresponding to a separately stored spreadsheet with attribute codes (Saldaña, 2021) on location, position, background, and type of establishment the respondents typically worked with/in. At this stage, automatic transcripts were also corrected for spelling errors. Two sets of interviews were analysed separately; moreover, each participant was studied as a separate case. First, two coders worked separately, then together using in vivo coding to identify main motifs (themes) in the interviews (Strauss & Corbin, 1994), first by identifying and coding repeating phrases and subsequently by grouping them into recurring themes (Kvale & Brinkmann, 2009). Additionally, the coders counted the frequency of keywords for various groups of respondents employing magnitude coding (Saldaña, 2021). The two interviewed groups are subsequently referred to as the OV group (OVs responsible for MI) and the FBO group (representatives, owners, or management of abattoirs).

Results and discussion

General overview and themes. Tables 2 and 3 present the frequency of themes categorised by researchers coding the interviews. The themes are reported to demonstrate that both groups from different parts of Sweden mentioned similar concerns, opportunities, and challenges related to AMI and PMI.

Interestingly, the interviewers have not, at any point during the interview, suggested or mentioned any type of technological solution that could potentially be employed for remote inspections. At the same time, all respondents assumed that remote inspections would be done by live video transmission (streaming) via the internet and all keywords coded by the researchers as “design cues” pertained to organisation of streaming services.

Out of 19 respondents, all had prior experience with online video and sound streaming technologies at work, e.g., meetings via Microsoft Teams or Zoom, and only one FBO respondent rarely took part in online meetings. On the other hand, only four respondents (all FBO) had any prior experience with remote meat inspection, while two OVs conducted remote inspection of FCI documents during the COVID-19 pandemic. This prior experience with (pilot) remote inspections was one of the main differences between FBO and OV participants. The frequency of the same keywords used in both groups was similar which is demonstrated in Tables 2 and 3. However, given the roles and responsibilities of FBO and OV, similar topics were often approached from different angles. These differences are further elaborated in the discussion of each theme below.

We also calculated the number of times the respondents were referring to themselves (I-statements) and the number of “we-statements” indicating that respondents were identifying with their stakeholder group or their workplace. This calculation can indicate that all respondents were answering the questions mainly from their own perspective.

Figure 2 outlines the general overview of both stages of MI. The figure shows the optimal inspection flow as described by respondents from both groups. Respondents also identified stages during standard MIs when potential issues were most likely to occur. The stages in Figure 2 were also indicated as key points when remote technology could be applied. Below, we describe subsequent steps of an optimal MI including how-according to our respondents – remote technologies could potentially affect each step.

Ante mortem inspection. All participants from both groups mentioned that whereas unloading of animals is key in observing the animals’ behaviour and unrestricted movement, it was seldom possible for the OV to be present, due mainly to long travelling distances, shortages of staff, and in some specific cases such as farmed game slaughter (reindeer), difficulties in predicting with a sufficient time margin when a transport of animals would arrive at an abattoir. At this stage of MI, remote controls were unanimously identified as having a positive impact on the process as the presence of an OV at the point of unloading could be ensured by the streaming technology.

The AMI inspection that occurs once the animals have been moved into the pens or lairage has also been described in detail. Participating OVs mentioned that existing conditions could affect their work. The most mentioned concern voiced by the majority was that lighting conditions could potentially negatively affect the quality of video streaming. Additionally, in some abattoirs, inadequate space and possible coverage of the pens could prevent observing the animals from all sides. Time pressure was mentioned as another major obstacle that could be additionally exacerbated in remote inspections. Ten out of fourteen participating OVs mentioned relying on their own “creative solutions”, such as wearing headlamps, using torchlights, or jumping fences and walls to adapt to existing conditions. This occurs despite the EU legislation quite clearly demanding suitable working conditions for both AMI and PMI.

Assistance of the abattoir staff in conducting AMI was identified as another issue that could affect remote AMI. Responding OVs again mentioned time pressure, insufficient assistance, and communication problems, especially language barriers as abattoir personnel are often seasonal workers that come from outside of Sweden. There were concerns that communication issues could be anew exacerbated in remote AMI with misheard instructions or information not relayed correctly. At the same time, one FBO participant mentioned that remote controls could be challenging due to staff shortages, as extra personnel would be necessary to handle the animals and ensure the video transmission worked correctly. However, both OV and FBO groups mentioned potential positive effects on the animals with less stress related to interacting with strangers and more available space during a remote AMI especially in places where pens are already small.

Post mortem inspection. Another major issue identified by participants working in larger abattoirs was the slaughter line speed. Several of the respondents in the FBO group have worked remotely with inspections (not AMI or PMI), and there was a concern among them that remote controls will not be able to keep up with the current production speed, which would need to be adapted to video streaming. Neither OVs nor FBO respondents working in small- and medium-sized abattoirs were concerned about this potential problem, given that the output of low-capacity abattoirs is significantly lower than of the large ones. OVs working in some abattoirs mentioned even issues related to accessing tools, such as sterilised sharp knives and amenities. The availability and readiness of such tools would have to be ensured by the on-site technical support assisting remote PMI. The SFA’s model for the flexibility for remote AMI and PMI is aimed to be used only in certain conditions, in low-capacity abattoirs and game-handling establishments (Kautto, 2022) when PMI is conducted at the end of the slaughter line or in the chilling rooms.

Attitudes towards remote meat inspection. Overall, expressed attitudes towards remote MI both among OVs and the FBO group were fairly positive. Notably, OVs were more cautious and while in general positive, they also voiced more concerns over remote MI than FBOs. There was also a difference between OVs working in managerial roles

Table 2
Frequency of keywords in all interviews with the OV group. N = 14; respondents were divided into three subgroups, depending on their workplace (North; Middle Sweden; South). A researcher worked on highlighting and counting the codes (in vivo coding) in structured, anonymised list of all interviews. The second column shows the frequency of keywords for the whole group (N = 14) in descending order (from the most to the least detected, except for the I- and we-statements). Participants were grouped according to their control areas and not the type of establishment they work with as most OVs we interviewed has worked with more than one type of establishment and more than one animal group

	Total (Sweden)	North (n = 5)		Middle (n = 5)		South (n = 4)		
Category (subtheme)	Keywords	Keywords	Keyword %	Keywords	Keyword %	Keywords	Keyword %	Example codes
Routines and regulations	725	235	10.4%	274	14.3%	216	7.7%	control, inspection, legal framework, regulations, legal requirement
Work conditions	511	242	10.7%	144	7.5%	125	4.5%	light, dark, low light, box space, work conditions
Abattoir	500	186	8.3%	121	6.3%	193	6.9%	Abattoir, slaughter, company
Design cues	427	147	6.5%	125	6.5%	155	5.5%	camera, digital, tracing, internet connection, secure, film
Animal welfare and health	321	86	3.8%	107	5.6%	128	4.6%	welfare, illness, hooves, cleanliness, parasites
Negative aspects	287	88	3.9%	128	6.7%	71	2.5%	cheating, risk, challenge, problem, abuse
Travel (work-related travel)	194	80	3.5%	49	2.6%	65	2.3%	car, travel, work travel, mileage
Teamwork	180	72	3.2%	38	2.0%	70	2.5%	Manager, colleague, team, together
Organization	171	75	3.3%	59	3.1%	37	1.3%	SFA (*Livsmedelsverket*), County Administrative Board (*Länsstyrelsen*), governmental organisation
Remote work	136	43	1.9%	44	2.3%	49	1.7%	Teams, remote work, working from home
Quality	97	32	1.4%	41	2.1%	24	0.9%	quality
Recruitment and workforce	68	19	0.8%	15	0.8%	34	1.2%	staff shortage, recruitment, district vet
Consumers	53	24	1.1%	5	0.3%	24	0.9%	consumer protection, shop, restaurant, consumer
I-statements	1848	530	23.5%	634	33.0%	684	24.4%	number of times “I” was used in a sentence
We-statements	1034	311	13.8%	263	13.7%	460	16.4%	number of times “we” was used in a sentence
Total tokens	69743	22536	100%	19202	100%	28005	100%	

at different levels in the competent authority and OVs working only with AMI and PMI. The first group was more focused on the potential positive impact on daily issues the managers face, such as recruitment problems and lack of skilled OVs. The latter group was less uniformly positive with the general attitudes being more varied; some respondents were positive, but the majority remained cautions and mentioned existing issues, especially related to work conditions, as described in Figure 2.

Perceived risks of and prerequisites for implementing remote AMI and PMI. It was somewhat challenging to divide the responses provided by our participants into separate categories of perceived risks and prerequisites for implementing remote MI. Respondents often voiced concerns about potential risks associated with remote MI and at the same time described necessary features of the system that would mitigate the risk. Therefore, responses were categorised into four broad themes described in detail below.

Technical risks and features of a remote inspection system. The majority of interviewed OVs quoted existing physical challenges, such as poor lighting conditions and limited space as the main technical risks for conducting remote MI; there were concerns that external conditions that could potentially obstruct AMI and PMI would be exacerbated in remote MI. The second technology-related concern pertained to the sense of smell and touch. OVs working with all species, but especially pigs, mentioned the importance of smell and palpation, both in AMI and PMI. The risk that those types of information would be lost or impossible to relay via video streaming was mentioned by 10 out of 14 interviewed OVs.

Risks related to poor connectivity and unstable internet transmission were the third most mentioned technological challenges. Interestingly, none of the OVs we interviewed has ever conducted a remote MI. However, 4 out of 5 FBOs, either took part in pilot trials of remote AMI or PMI (one respondent), or conducted other types of remote controls during the COVID-19 pandemic, for instance a remote audit of the premises. All participants with practical experience of remote MI stressed that it was necessary to ensure a stable internet connection both inside and outside the abattoir, and that the mobile internet network coverage had been insufficient inside the buildings prior to the pilot trials. During the remote trials, internal Wi-Fi systems with new routers were installed at the slaughter line, chilling rooms, and lairage area in some abattoirs. Given that remote MI could possibly replace MI on-site in well-defined conditions in sparsely populated and remote areas, a fast and reliable internet or good enough (5G) mobile net connection is an indispensable part of the technology supporting remote MI. The final technology-related challenge mentioned by the respondents was the quality of video and sound transmission. The main risk mentioned by the participating OVs in this area was colour reproduction. According to the responding OVs, sometimes subtle colour nuances can play a crucial role in PMI, therefore, both software and hardware used for remote MI must be able to accurately relay colours. In these cases, there is a legal support for the OV to travel to the site in order to be able to take a suitable MI decision for possible health marking (European Commission, 2019).

Security and safety of the technical solutions. There were several types of risks mentioned by respondents in both groups pertaining to digital security and safety, namely: access concerns, possible interruptions in video transmission, and the risk of manipulating the system.

Access rights and concerns over unauthorised access to stored data have taken centre stage in the increasingly digital communication worldwide and affect any type of remote work equally, including possible remote MI. Only 2 out of 14 participating OVs voiced concerns over data access and storage. Assuming that remote MI would be conducted by means of an existing video streaming technology, the data would be indeed handled and stored by a third party.

Table 3
Frequency of keywords in interviews with the FBO group, N = 5. A researcher worked on highlighting and counting the keywords (codes) in structured, anonymised list of all interviews. The second column shows the frequency of keywords for the whole group (N = 5) in descending order (from the most to the least detected, except for the I- and we-statements)

	Managers/owners of abattoirs or game establishments, whole Sweden (n = 5)		
Category (subtheme)	**Keywords**	**Keyword %**	**Example codes**
Industry and processes	262	10.6%	abattoir, slaughter, company, production line, meat processing
Routines	254	10.3%	control, inspection, legal framework, regulations, legal requirement
Design cues	171	6.9%	camera, digital, tracing, internet connection, secure, film
Negative aspects	130	5.3%	cheating, risk, challenge, problem, abuse
Organisation	122	4.9%	SFA, County Administration, governmental organisation
Animal welfare	82	3.3%	welfare, illness, hooves, cleanliness, parasites
Animals (in general)	81	3.3%	species, behaviour, etc.
Remote work	73	2.9%	Teams, remote work, working from home
Travel and transport	70	2.8%	car, travel, work travel, mileage
Work conditions (health and safety)	37	1.5%	light, dark, low light, box space, work conditions
Optimisation	32	1.3%	optimisation, planning, prioritising, weekly schedules, planned work
Positive aspects	31	1.3%	positive, hopeful, positive aspects
Quality	30	1.2%	quality
Consumers	18	0.7%	consumer protection, shop, restaurant, consumer
Teamwork	15	0.6%	Manager, colleague, team, together
Recruitment/workforce/personnel	10	0.4%	staff shortage, personnel, shortage of vets
I-statements	585	23.7%	number of times “I” was used in a sentence
We-statements	470	19.0%	number of times “we” was used in a sentence
Total tokens	2473	100%	

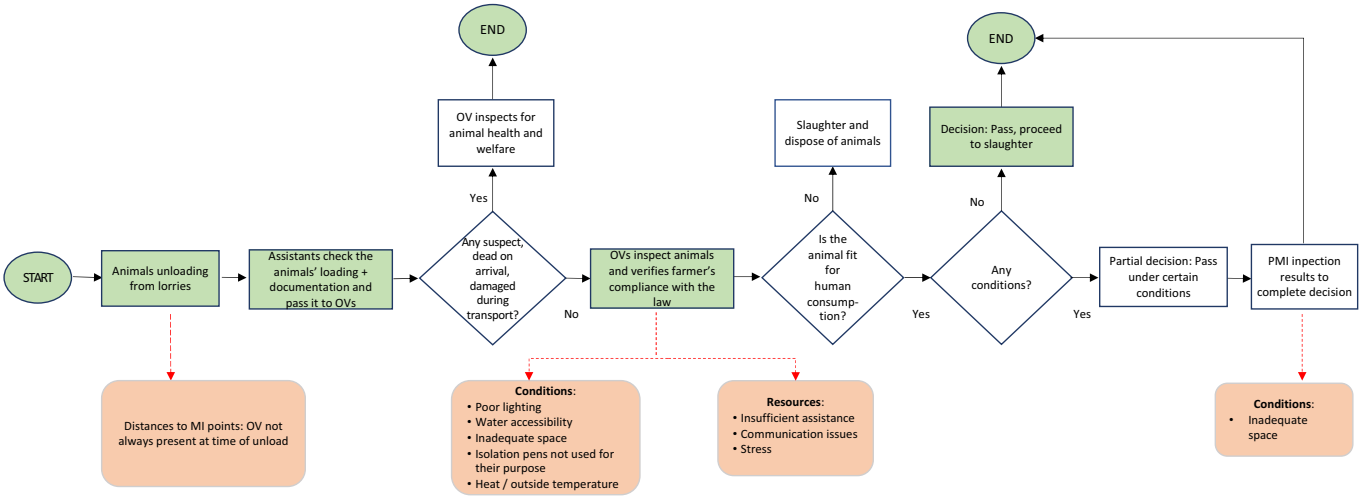

Figure 2. Ante-mortem and post-mortem inspection workflow. Orange rectangles list the most common issues that can occur during the control. Source: authors.

Another concern, voiced by 6 of the interviewed OVs, was the possibility of manipulating the system, e.g., modifying the transmission for a certain desired outcome, or deliberately showing some elements during the control process while obscuring other, undesirable aspects. Participating OVs stressed repeatedly that there needed to be a possibility to relay requests to assisting personnel in such a way that the requests were relayed correctly and resulted in appropriate action, e.g., showing an animal from a different angle, or showing close-ups of certain parts such as hooves. Several participants from both groups suggested the need for a digital solution, such as a time stamp of the live video streaming and a digital health-mark for meat validated as safe for human consumption. The techniques available for time stamps already exist. Health marking stamps must be under OVs' control all the time. Today, it is not a practical problem because OVs are on-site. In remote PMI, a possible technical solution would be a lockbox for the official stamp that can be operated remotely.

Possible interruptions that can occur during remote MI due to unstable internet connection were mentioned by participants from both groups as a risk that could cause information loss, misunderstandings or, in the worst-case scenario, an event that would invalidate the interrupted remote MI. One respondent from the FBO group who had had hands-on experiences with remote MI pilots recalled replacing the network infrastructure in and around the abattoir to prevent connectivity issues.

Design cues and principles. Our respondents offered various opinions on how the system of remote MI could be organised, and even though the majority had no prior experience with remote MI, all participants suggested solutions, design cues, and the so-called design principles (Fu et al., 2016).

Respondents were unanimous that a remote MI would require cameras. There was, however, no agreement on how the cameras should be located. 3 out of 19 participants suggested a combination of fixed

Table 4
Potential impact of remote meat inspection in four predefined areas: animal welfare, environment, work efficiency, quality of meat inspection

Predefined areas	Potential impacts		
	Negative	Uncertain	Positive
Animal Welfare	None	• Less control over the inspection when OV is not physically present	• Less stressful for the animals • Shorter time spent in transport and/or abattoir
Environment	None	None	• Less time spent driving
Work Efficiency	• Can take longer in practice • Inability to employ more senses (smell & touch)	• Less enjoyment and/or satisfaction from work • Digi-physical interaction[1] • Standardised input	None
Quality of Control	• Missing injured animals & risk of disease spreading • Meat quality (risk of incorrectly classifying meat unfit for human consumption) • Less mindful of surroundings	None	None

[1] Digi-physical interaction assumes a combination of digital and physical contact or, alternatively, defines experiences/occurrences that materialize as results of interaction between digital tools (such as online meetings) and physical events.

cameras, in the form of close-circuit television (CCTV) or surveillance in addition to hand-held devices. The most mentioned location for a fixed camera was at the point of unloading the incoming animals from transport vehicles. The most popular option mentioned by OVs was hand-held devices. However, some participants suggested body cameras – head- or hand-mounted, leaving the hands of the person streaming the video free to move the inspected animals or manoeuvre obstacles. However, respondents with prior experience of remote MI who acted as the party reviewing the video stream, reported problems with motion sickness occurring when the camera moved too fast or in unpredictable directions. On the other hand, one of the FBO respondents who took part in pilot remote MI as the filming party, advocated strongly against hand-held devices. The respondent, working in a low-capacity facility, reported that using a hand-held camera required more than one person to assist in the MI, which could be difficult due to staff shortages. It can be concluded that a combination of fixed cameras, body cameras with a very detailed protocol outlining the steps of remote MI and its minimum duration could possibly address both issues with staff availability and motion sickness at the same time.

Another vital point most participants mentioned was that the remote MI system needed to be designed for transparency, to ensure trust is built and maintained between participants. It should be clear from the start how the data are streamed, used, and stored. There should also be risk-mitigation measures in place, transparent for all stakeholders that address a variety of critical situations, such as transmission issues, connectivity problems, or communication problems. Two FBO participants who took part in pilot remote MI project mentioned mutual trust between parties carrying the MI that allowed both sides to react quickly and adapt to changing situations. Trust in the system could be also built and maintained by clear instructions on the one hand, and clear expectations on the other. Respondents mentioned that it was important to fully understand what a system of remote MIs could do, including its possible limitations, and how well it could perform.

Another feature, described by most respondents through many examples of their daily work, was efficient dismissal or correction of incoming information, and focus on contextually relevant information. In practice, the participants mentioned examples such as location of fixed cameras in places where MI typically takes place, ability to ask the operating personnel to move animals, zoom in on parts such as hooves, or ensuring that instructions are followed. All these concerns address the known condition of asymmetric information flow which contributes to increased perceived risk among FBOs and can negatively affect the meat value chain.

Financing of remote meat controls. It was not clear for the participants who would finance the equipment needed for remote MI and some voiced concerns that a blanket solution would be needed to ensure timely and standardised introduction of remote MI. Some OVs at the managerial level mentioned that a cost-benefit analysis needs to be conducted prior to introducing any new technological solutions. Two out of five participants from the FBO group mentioned possible financial impacts of remote MI and the need to reorganise work. The impact mentioned could be both positive, with faster turnover (animals would not need to wait for OVs or stay overnight) and negative, with the slaughter line speed adapted to remote MI. One participant from the FBO group mentioned that whereas his organisation could stand for the cost of equipment, it was expected that SFA would provide and finance personnel training to ensure that remote inspections are conducted in a uniform way. The costs of the official control in meat value chain are an important factor affecting consumer prices. The model in the SFA study considers low-cost alternatives as mobile phones and existing internet or mobile networks as well as personal computers already used in the official MI.

Perceived impact of remote controls. Respondents were asked to describe the perceived impacts of remote controls in four predefined areas outlined below. Overall, we received nuanced responses, with both positive and negative impacts reported. The results are summarised in Table 4 and elaborated below.

Animal welfare. The respondents mentioned both positive and negative impacts on animal welfare. The positive impacts mentioned by the FBO group were related to the possibly shortened waiting times. Participants mentioned that animals sometimes had to wait overnight in the stables for the OV which affected their welfare. The reindeer abattoir representative mentioned that they often dealt with young reindeer calves separated from their family group and facing significant stress. A report from SFA (Livsmedelsverket, 2010) mentioned that on average 44% of pigs and over 60% of sheep have to spend the night in the abattoir, being exposed to possible stress from mixing with animals from other herds and staying in an unknown environment. Another participant from the FBO group mentioned that remote MI would require reduced speed of slaughter lines. However, this aspect is not relevant in remote MI because only low-capacity abattoirs and game-handling establishments are to be considered for this flexibility.

Negative effects on animal welfare were also reported and overwhelmingly attributed to a lack of control over the process when an OV is not present. Some OVs mentioned already existing welfare concerns and breaches and they felt that limiting the OVs physical presence at the abattoirs would worsen the situation. Anyhow, the ultimate responsibility for the animal welfare is always on the FBO, not on official control. Another concern was related to handling of possible crisis situations: OVs were concerned that in case they noticed animal welfare problems during a remote MI, it would be difficult to

effectively address the issue. In these cases, there is a legal right for the OV to stop the slaughter and drive to the abattoir for further control (European Parliament and the European Council, 2017).

Environmental impact. The interviewees overall expressed consensus on the potential positive impact on the environment. This is particularly due to the significant reduction in work travels and travel-related emissions of greenhouse gases. This was especially relevant for long travels to reach remote sites.

However, some OVs were somewhat unsure about the potential positive impact on the environment. Indeed, they reckoned that frequent travelling would still be needed, as they believed that remote MI would never be able to fully replace on-site MI. This is supported by the fact that, the goal for the remote MI flexibility is to give a new technical option for the meat control not to replace on-site visits in total.

Work efficiency. Many participants agreed that work efficiency would be positively affected; however, this was also the area where participants were unsure about the long-term effects. The main mentioned impact was the reduced need to travel. At the same time, since none of the interviewed OVs conducted remote MI, it was challenging for the respondents to imagine how their daily work would be affected. The FBO group mentioned positive effects – reduced waiting time for the OV arrival, guaranteed presence of the OVs via remote link, but also possible longer duration of remote MI compared to traditional MI, due to reduced speed of slaughter line. However, in many low-capacity abattoirs, the PMI takes place just before carcasses enter the chilling room and remote PMI should not directly affect the slaughter speed.

Quality of controls. The attitude of the respondents in terms of quality of controls spanned between negative to uncertain. It is worth adding that, similar to the perceived impact on work efficiency, the lack of experience in conducting remote MI hindered the ability of the interviewees to clearly depict how the new technology might affect their tasks. The main worries related to the possibility of missing injured animals and the risk that infected animals would not be detected with the consequence of spreading diseases. Additionally, there might be the risk of being less mindful of the surroundings which play a key role in providing essential information in the MI process. Moreover, an area of significant uncertainty was identified in the integration between digital and physical (on-site) interaction in animal inspection which was labelled as “digi-physical interaction” by the researchers. This can be clarified by quoting an OV:

> *“What if you find something serious, then it* [the animal] *must be slaughtered on the spot and maybe I'm 2 hours away?”.*

The interplay between digital and physical aspects of remote controls was seen as possibly affecting the quality of inspection and could originate in lower perceived (and actual, with the OV physically not present) control over MI in a remote process.

Overall, our respondents could envision MI conducted remotely. Remote locations and long travelling distances to smaller abattoirs and game-handling establishments are common, especially in Northern Sweden, therefore, remote MI were perceived as a sustainable choice. At the same time, many technical barriers and challenges need to be addressed before remote MI can even be considered a viable alternative to on-site controls.

The empirical results reported herein should be considered in the light of some limitations. First, the study is specific to Sweden therefore cannot automatically be generalised as such even if the EU regulations are applicable for all Member States and the health status of the animal populations is comparable. Typically, qualitative studies present a low degree of generalisability and in this case, a niche group was targeted. Moreover, the sample resulted to be self-selecting, as in all studies involving volunteers, given that respondents had to show interest in the study and could decline the interview invitations. However, efforts were made to recruit respondents from various backgrounds and geographical locations to ensure a variety of experiences and perspectives and given the total number of both OVs and small-scale abattoirs in Sweden, the sample size can be considered large. Nevertheless, some conclusions may be drawn and extended to other countries. In this case, this may include the use of technology and how it could be handled throughout the whole MI process. Further studies in other countries might just validate this point.

The food industry in general and the meat industry in particular are facing significant challenges today. To be able to reach sustainability goals considering the environment, good working conditions, animal health and welfare, and food safety as an ongoing co-operation of FBOs, official controls and third parts (e.g., auditing enterprises) is needed. Moreover, the cost-effectiveness of official controls needs to be considered. Ferri et al. (2023) point out OV as a central risk manager in MI. However, OVs are in crucial need of supporting tools in this activity.

Notwithstanding the identified challenges for remote MI that need to be addressed before remote MI can be considered alongside on-site controls, we postulate that the remote MI can become a viable option offering more flexibility in MI in the future. Conditions to be fulfilled for performing MI on remote basis are to be defined in connection to this flexibility option in EU regulations. The conditions to be defined are, for example, the equipment to be used, minimum broadband/mobile internet network capacity, animal health conditions in the area of uptake for the abattoir, size of the abattoir or game-handling establishment, training of the control and FBO personnel. A solid body of evidence is needed to support potential new flexible regulations, and further research, especially in the form of applied pilot studies testing remote MI in a variety of conditions, is crucial. Moreover, even more comparative studies between remote and on-site controls in different countries would be beneficial in establishing a set of criteria to assess quality, efficiency, and robustness of remote MI against agreed standards across the whole EU. In any case, food safety, animal health, and welfare must never be compromised.

Ethical statement

This study was conducted with human subjects, adult volunteers whose informed consent was obtained before the beginning of data collection. Informed consent was thus an inherent part of the planned research, as participants are informed about the purpose and the objective of a study before they agree to participate. Researchers ensured at every step of the process that the rights of participants to voluntarily provide answers to scientific inquiries were respected. We did not collect data from minors, other potentially vulnerable groups, or any sensitive personal data, as defined by the Swedish Act (2003:460) on research involving humans.

The project staff ensures confidentiality of personal data collected for research purposes, including anonymization, adequate storage and handling of records, in case such data were collected. The project staff also ensures that the collection of any potentially identifying information is only reserved to cases when full privacy preservation is not possible, for instance, in recording images and sound for data analysis purpose. Any potentially identifying information that could be directly linked to participants, such as images, are kept confidential. Moreover, any identifying information are not reported in any resulting project publications and materials such as websites, reports, scientific publications or teaching materials, unless participants explicitly agree otherwise.

Researchers conduct all studies involving handling of personal information in line with their respective national research ethics guidelines, including the RISE Code of Conduct, and the General Data Protection Regulation (EU) 2016/679.

In Sweden the relevant body is the Swedish Ethical Review Authority (SERA), and according to the Swedish Act (2003:460) on research involving humans, the proposed research does not require SERA's approval.

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.

Acknowledgements

The authors would like to extend their gratitude to dr. Derek Diener at RISE Research Institutes of Sweden for the final language control.

Appendix A. . Interview guides

The interview guide is based on the Value Proposition Canvas (VPC) framework, presented in Figure 1. The questions below are referenced to corresponding parts of VPC. The second interview guide (FBO) follows the same structure

Interview guide (OV):

- Introduction (these questions are intended as: 1) icebreakers and 2) confirmation of respondent's role and responsibilities)
  - Briefly describe your typical day at work (kind of tasks you have, etc.) (Customer Jobs)
  - What is the most relevant for you to make sure that you perform your tasks as required? (Customer Jobs)
  - Do you work with all types of animals? Is there any group/type that you prefer to work with and why? (Customer Jobs)
  - To get your job done, do you need to interact with others? If so, who are they and what do they do?
- AMI (VPC areas: Customer Profile/Value Map)
  - Could you please describe how an ideal/optimal AMI looks like in your opinion? (Gains)
  - What are the main risks in not getting the job done (financial, social, or technical)? (Pains)
  - Is there anything preventing you from getting AMI done according to your (ideal, personal) standards? (Pains)
  - Do you have opportunity to think or try innovative solutions? If so, please describe what, when, how, etc.? (Pain Relievers)
- PMI
  - Could you please describe how an ideal/optimal PMI looks like in your opinion? (Gains)
  - What are the main risks in not getting the job done (financial, social, or technical)? (Pains)
  - Is there anything preventing you from getting PMI done according to your (idea, personal) standards? (Pains)
  - Do you have opportunity to think or try innovative solutions? If so, please describe what, when, how, etc. (Pain Relievers)
- Distance/remote work
  - Have you had any opportunity to inspect FBO remotely (document control)? (Customer Jobs)
  - How was the experience overall? (Customer Jobs)
  - (If not) How, in your opinion, remote work should be organised ideally? (Customer Jobs)
- Doing AMI & PMI remotely
  - Can you imagine doing AMI & PMI remotely? What would be advantages/disadvantages? (Products/Services)
  - What quality or other features would you wish for more or less of in such a technology? (Gain Creators/Pain Relievers)
  - Are you overall pro or against? (Customer Gains/Customer Pains)
  - What do you think would be the consequences for working remotely (AMI) for:
    - Animal welfare
    - Environment
    - Work efficiency
    - Quality of control (Gain Creators/Pain Creators)
- Is there anything else you would like to add?
- Please feel free to email us or get in touch if there is anything that springs to mind later.

Interview guide (FBO):

- Introduction
  - Briefly describe your typical day at work (kind of tasks you have, etc.)
  - What is the most relevant for you to make sure that you perform your tasks as required?
  - Do you work with all types of animals? Is there any group/type that your company specialises in and why?
  - To get your job done, do you need to interact with others? If so, who are they and what do they do?
- AMI
  - Could you please describe how an ideal/optimal AMI looks like in your opinion?
  - What are the main risks for the company for not getting the AMI done (financial, social, or technical)?
  - Is there anything at your workplace that could prevent AMI getting done according to your (ideal, personal) standards?
  - Is there somebody formally in charge of innovation in your company? How is the topic of innovation/new solutions dealt with in your company?
  - Do you have opportunities to discuss your suggestions for innovative solutions with vets doing AMI or Livsmedelverket? (Customer Jobs)
- PMI
  - Could you please describe how an ideal/optimal PMI looks like in your opinion?
  - What are the main risks in not getting the job done (financial, social, or technical)?
  - Is there anything preventing you from getting PMI done according to your (idea, personal) standards?
  - Is there somebody formally in charge of innovation in your company? How is the topic of innovation/new solutions dealt with in your company?
  - Do you have opportunities to discuss your suggestions for innovative solutions with vets doing AMI or Livsmedelverket?
- Distance/remote work
  - Have you had any opportunity to work remotely?
  - How was the experience overall?
  - (If not) How, in your opinion, remote work should be organised ideally?
- Doing AMI & PMI remotely
  - Can you imagine that AMI & PMI is done remotely?
  - What is needed in your company to make remote controls work?
  - What quality or other features would you wish for more or less of in such a technology?
  - Pros and cons for you as a business – what would you gain/lose?
  - Are you overall pro or against?
  - What do you think would be the consequences for working remotely (AMI) for:

- Animal welfare
- Environment
- Work efficiency
- Quality of control

- Is there anything else you would like to add?
- Please feel free to email us or get in touch if there is anything that springs to mind later.

References

Alexandropoulou, V., Johansson, T., Kontaxaki, K., Pastra, A., & Dalaklis, D. (2021). Maritime remote inspection technology in hull survey & inspection: A synopsis of liability issues from a European Union context. *Journal of International Maritime Safety, Environmental Affairs, and Shipping, 5*(4), 184–195. https://doi.org/10.1080/25725084.2021.2006463.

Almqvist, V., Berg, C., & Hultgren, J. (2021). Reliability of remote post-mortem veterinary meat inspections in pigs using augmented-reality live-stream video software. *Food Control, 125* 107940.

Belleflamme, P., & Neysen, N. (2021). A multisided value proposition canvas for online platforms. *Journal of Business Ecosystems (JBE), 2*(1), 1–14.

Blaha, T. (2012). One world-one health: The threat of emerging diseases. A European perspective. *Transboundary and Emerging Diseases, 59*(s1), 3–8. https://doi.org/10.1111/j.1865-1682.2011.01310.x.

Breneman, J. E., Sahay, C., & Lewis, E. E. (2022). *Introduction to reliability engineering*. John Wiley & Sons.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science, 35*(8), 982–1003. https://doi.org/10.1287/mnsc.35.8.982.

De Meulenaer, S., De Pelsmacker, P., & Dens, N. (2018). Power distance, uncertainty avoidance, and the effects of source credibility on health risk message compliance. *Health Communication, 33*(3), 291–298.

Deuss, A., & Honey, S. (2023). Costs, benefits and effectiveness of remote audits for international food safety. In *OECD Food, Agriculture and Fisheries Papers* (Vol. 196). https://www.oecd-ilibrary.org/content/paper/fef97106-en

Efsa (2012). Scientific Opinion on the public health hazards to be covered by inspection of meat (poultry). *EFSA Journal, 10*(6) 2741.

Efsa (2013). Scientific Opinion on the public health hazards to be covered by inspection of meat (solipeds). *EFSA Journal, 11*(6), 3263. https://doi.org/10.2903/j.efsa.2013.3263.

Eiser, J. R., Miles, S., & Frewer, L. J. (2002). Trust, perceived risk, and attitudes toward food technologies 1. *Journal of Applied Social Psychology, 32*(11), 2423–2433.

Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin, OJ L (2004). http://data.europa.eu/eli/reg/2004/853/oj/eng

EUR-Lex—32019R0624—EN. Commission Delegated Regulation (EU) 2019/624 of 8 February 2019 concerning specific rules for the performance of official controls on the production of meat and for production and relaying areas of live bivalve molluscs in accordance with Regulation (EU) 2017/625 of the European Parliament and of the Council (Text with EEA relevance.), (2019). https://eur-lex.europa.eu/eli/reg_del/2019/624/oj

Regulation (EU) 2017/625 of the European Parliament and of the Council of 15 March 2017 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products, amending Regulations (EC) No 999/2001, (EC) No 396/2005, (EC) No 1069/2009, (EC) No 1107/2009, (EU) No 1151/2012, (EU) No 652/2014, (EU) 2016/429 and (EU) 2016/2031 of the European Parliament and of the Council, Council Regulations (EC) No 1/2005 and (EC) No 1099/2009 and Council Directives 98/58/EC, 1999/74/EC, 2007/43/EC, 2008/119/EC and 2008/120/EC, and repealing Regulations (EC) No 854/2004 and (EC) No 882/2004 of the European Parliament and of the Council, Council Directives 89/608/EEC, 89/662/EEC, 90/425/EEC, 91/496/EEC, 96/23/EC, 96/93/EC and 97/78/EC and Council Decision 92/438/EEC (Official Controls Regulation)Text with EEA relevance., 095 OJ L (2017). http://data.europa.eu/eli/reg/2017/625/oj/eng

FAO CAC/GL 82-2013. (2013). *Principles and guidelines for national governments for national food control system* [CAC/GL 82-2013].

Felin, E., Jukola, E., Raulo, S., Heinonen, J., & Fredriksson-Ahomaa, M. (2016). Current food chain information provides insufficient information for modern meat inspection of pigs. *Preventive Veterinary Medicine, 127*, 113–120.

Ferri, M., Blagojevic, B., Maurer, P., Hengl, B., Guldimann, C., Mojsova, S., ... Johler, S. (2023). Risk based meat safety assurance system – An introduction to key concepts for future training of official veterinarians. *Food Control, 146*. https://doi.org/10.1016/j.foodcont.2022.109552 109552.

Fu, K. K., Yang, M. C., & Wood, K. L. (2016). Design principles: Literature review, analysis, and future directions. *Journal of Mechanical Design, 138*(10) 101103.

Goodhue, D. L., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly*, 213–236.

Kautto, A. H. (2022, April 7). *Remote meat control—From opportunity to obligation?* https://ribmins.com/wp-content/uploads/2022/04/7_4_2022_4_Arja-Helena-Kautto.pdf

Kautto, A. H., & Comin, A. (2023, March 29). Remote meat inspection with digital devices in small-scale slaughter and game handling in Sweden as part of future sustainable meat safety assurance system. *3rd RIBMINS Scientific Conference*. 3rd RIBMINS Scientific Conference Shaping the Future of RB-MSAS, Bucharest. https://ribmins.com/wp-content/uploads/2023/03/RIBMINS-Proceedings-2023.pdf

Kershaw, K., Feral, B., Grenard, J.-L., Feniet, T., De Man, S., Hazelaar-Bal, C., ... Ingo, R. (2013). Remote Inspection, Measurement and Handling for Maintenance and Operation at CERN. *International Journal of Advanced Robotic Systems, 10*(11). https://doi.org/10.5772/56849 382.

Kvale, S., & Brinkmann, S. (2009). *Interviews: Learning the craft of qualitative research interviewing*. Sage.

Livsmedelsverket. (2010). *Rapport om Sveriges kontroll i livsmedelskedjan, 2010* (p. 147). https://www.livsmedelsverket.se/globalassets/publikationsdatabas/rapporter/2011/rapport_sveriges_kontroll_livsmedelskedjan_2010.pdf

Luukkanen, J., Kotisalo, N., Fredriksson-Ahomaa, M., & Lundén, J. (2015). Distribution and importance of meat inspection tasks in Finnish high-capacity slaughterhouses. *Food Control, 57*, 246–251.

Mahmud, R., Scarsbrook, J. D., Ko, R. K. L., Jarkas, O., Hall, J., Smith, S., & Marshall, J. (2023). Realizing credible remote agricultural auditing with trusted video technology. *Journal of Cybersecurity, 9*(1). https://doi.org/10.1093/cybsec/tyad012 tyad012.

Marshall, M. N. (1996). The key informant technique. *Family Practice, 13*, 92–97.

Meng, L., Somenahalli, S., & Berry, S. (2020). Policy implementation of multi-modal (shared) mobility: Review of a supply-demand value proposition canvas. *Transport Reviews, 40*(5), 670–684.

Michelsen, Ø. (1998). Use of reliability technology in the process industry. *Reliability Engineering & System Safety, 60*(2), 179–181.

Mix, P. E. (2005). *Introduction to nondestructive testing: A training guide*. John Wiley & Sons.

Osterwalder, A., Pigneur, Y., Bernarda, G., & Smith, A. (2015). *Value proposition design: How to create products and services customers want*. John Wiley & Sons.

Pokorná, J., Pilarõ, L., Balcarová, T., & Sergeeva, I. (2015). Value proposition canvas: Identification of pains, gains and customer jobs at farmers' markets. *AGRIS On-Line Papers in Economics and Informatics, 7*(665–2016–45080), 123–130.

Ribeiro, D., Santos, R., Shibasaki, A., Montenegro, P., Carvalho, H., & Calçada, R. (2020). Remote inspection of RC structures using unmanned aerial vehicles and heuristic image processing. *Engineering Failure Analysis, 117*. https://doi.org/10.1016/j.engfailanal.2020.104813 104813.

Rogers, E. M. (1976). New product adoption and diffusion. *Journal of Consumer Research, 2*(4), 290–301.

Saldaña, J. (2021). *The coding manual for qualitative researchers*. SAGE.

Satterfield, T., Kandlikar, M., Beaudrie, C. E., Conti, J., & Herr Harthorn, B. (2009). Anticipating the perceived risk of nanotechnologies. *Nature Nanotechnology, 4*(11), 752–758.

SOU 2022:58. (2022). *Bättre förutsättningar inom djurens hälso- och sjukvård* (Statens Offentliga Utredningar 2022:58).

Stärk, K., Alonso, S., Dadios, N., Dupuy, C., Ellerbroek, L., Georgiev, M., Hardstaff, J., Huneau-Salaün, A., Laugier, C., & Mateus, A. (2014). Strengths and weaknesses of meat inspection as a contribution to animal health and welfare surveillance. *Food Control, 39*, 154–162.

Strauss, A., & Corbin, J. (1994). Grounded theory methodology: An overview. In *Handbook of qualitative research* (pp. 273–285). SAGE Publications Inc..