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Evaluation methods of surveillance systems and current practices

WP1 - Development of a conceptual evaluation framework

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Foreword

This document aims at reporting on the work that has been conducted as part of the task 2 of work-package 1 of the RISKSUR project. This task 2 is dedicated to systematic reviews of evaluation methods of surveillance systems and the current practices. It is divided into two different and independent subtasks: 1) a systematic review of economic assessments of surveillance systems, criteria and methods and 2) a systematic review of the guidelines, framework, methods and tools for the evaluation of surveillance systems. Because these two systematic reviews have been done independently, they are presented in independent sections.

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Section 1: Systematic review of economic assessments of surveillance systems, criteria and methods

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Abstract

Evaluating and understanding the costs and the benefits of animal disease mitigation strategies is necessary to provide rational information to achieve the most efficient surveillance and intervention. Because of the entwined roles of surveillance and intervention to achieve mitigation, conducting an economic evaluation of mitigation measures should target not only interventions but also surveillance strategies. The paper presents a systematic review of the economic evaluations of animal health surveillance systems. A total of 27 case studies were included. The research questions that have been addressed in these evaluations are discussed. The economic analyses used to answer these questions were cost analyses (6/27), cost-effectiveness analyses (8/27), cost-benefit analyses (6/27), cost-minimisation analyses (5/27) and other (2/27). The relatively small number of papers published on the area highlight that economic evaluation of surveillance is rare in animal health. The review discusses the potential relevance of economic approaches that are still underused for evaluating surveillance. Finally, most economic evaluations were found to focus on surveillance systems targeting a single disease, even though an economic evaluation of surveillance would ideally cover different diseases and across multiple geographical regions.

1 Introduction

Animal diseases causing morbidity or mortality may decrease productivity and cause economic loss to society. Livestock diseases may reduce the quantity or quality of products for human consumption such as milk, meat, eggs, wool and hides, leading to potential massive losses. For example, during the foot-and-mouth disease epidemic in the United Kingdom in 2001, agricultural producers suffered losses estimated at £355 million, representing around 20% of the total farming income for 2001 (Thompson et al., 2002). In certain contexts, negative effects of diseases may have even wider-reaching consequences. In low and middle income countries where livestock functions as income, asset, social security, food and dowry, diseases can be an important threat to people's livelihoods. Finally, animal diseases may reduce the availability of animals for work or leisure, be it working animals (e.g. sniffer dogs, draft power), sports animals (e.g. horses for racing) or simply companions.

Zoonotic diseases transmitted directly through contact with infected animals (e.g. rabies infection through bites) or the ingestion of contaminated food or water (e.g. campylobacter on chicken meat), cause human illness and even death. This leads to economic losses due to the human deaths, reduction in productivity and reduced income. For example, the total annual global cost of human deaths from canine rabies has been estimated at tens of billions of dollars (Shwiff et al., 2013). While some diseases are characterised by acute bouts, others cause chronic conditions associated with permanent economic losses. In public health, although these diseases are not strictly zoonotic, average global burden due to salmonella, *Escherichia coli*, campylobacter and cryptosporidia in 2010 was estimated at 510 Disability-Adjusted Life Years (DALYs) per 100,000 persons, i.e. 12.4% of the total burden due to diarrhoea, lower respiratory infections, meningitis, and other common infectious diseases (Murray et al., 2012).

Apart from the debilitating consequences of human illness derived from zoonotic diseases, people's fears of contracting foodborne diseases may discourage them from purchasing or consuming animal products. As an example, the discovery of the link between new-variant Creutzfeldt-Jakob disease and bovine spongiform encephalopathy caused a substantial reduction in demand for beef in Japan in 2001 (McCluskey et al., 2005). In low and middle income countries where substitution possibilities for the foods in question may be limited, consumers only have two basic choices: either they consume the food despite the (perceived or real) risk of foodborne disease, or they decide not to eat the food which could potentially lead to malnutrition. Either choice can contribute to the vicious cycle of malnutrition and infection, where diarrhoea can cause a reduction in appetite and malabsorption, and undernutrition impairs the immune response thus predisposing people to infection (Bhaskaram, 2002). Another loss to human well-being occurs due to the negative effects of animal disease on the ecosystem. For example, collapsing colonies of honey bees seem to be caused by multiple complex factors including the presence of varroa mites and viruses in conjunction with the intensive use of pesticides (Le Conte et al., 2010). Growing evidence suggests that a general decline in pollinators in many regions worldwide may significantly affect ecosystem stability, crop production and therefore human welfare (Potts et al., 2010).

Many public and private institutions, such as public and animal health services, industry bodies and farmers, use mitigation strategies to limit economic losses by avoiding, containing, reducing, or removing a hazard. This process of such mitigation, however, comes at another economic cost. Two common elements to mitigate the negative effects of animal disease are surveillance and intervention (Häsler et al., 2011b). Surveillance is defined as "the systematic, continuous or repeated, measurement, collection, collation, analysis, interpretation and timely dissemination of animal health and welfare related data from defined populations, essential for describing health hazard occurrence and to contribute to the planning, implementation, and evaluation of risk mitigation measures" (Hoinville et al., 2013). Thus surveillance provides information for decisions regarding the implementation of interventions. Intervention on the other hand is the process of implementing measures directed at mitigation. Together, surveillance and intervention achieve loss avoidance, the outcome decision-makers are ultimately interested in (Howe et al., 2013). However, both surveillance and intervention use resources that could be used for other purposes in the absence of disease and have a positive opportunity cost.

Larger livestock populations, increased production intensity, changes in trade volumes and patterns, and the use of new habitats have produced an environment that facilitates the emergence and the spread of pathogens (Morse, 1995; Daszak et al., 2000; Jones et al., 2008). Recent pandemics of avian influenza, African swine fever and swine influenza have prompted renewed demand for more effective surveillance and intervention systems. At the same time, governments are required to reduce their animal disease mitigation expenditure in response to fiscal constraints. For these reasons, there is a demand for efficient mitigation strategies that generate outputs in relation to the health status of the animal populations, allowing appropriate management of any emerging or existing risks. Frameworks for economic evaluations, defined as “the comparative analysis of alternative courses of action in terms of both their costs and consequences” (Drummond et al., 2005), provide a systematic structure to study such issues.

In the public health sector, guidelines for the economic evaluation of surveillance and intervention have been proposed following international calls for enhanced surveillance and response capacities at the country level and the recognition of the need for further evaluation of costs and benefits of these systems. For example, the World Health Organization proposed guidelines and methods for assessing the costs and the benefits of national surveillance systems (WHO, 2005). The practical applications of these economic assessments to surveillance systems have emphasized their usefulness for public health, but have also highlighted constraints surrounding data availability to populate the economic models developed (Elbasha et al., 2000; Somda et al., 2010).

In the animal health sector, the principles of economic assessment for disease control have been presented for different contexts from the farm level to national and international levels (Rushton et al., 1999). The economic rationale for investments in animal health is that the value of losses avoided (the benefit from the mitigation) is at least sufficient to cover the additional costs needed for disease control (McInerney et al., 1992). Because disease control programmes comprise both surveillance and intervention measures that are inextricably linked, control costs corresponds to the sum of surveillance costs and intervention costs. Identifying the optimal level for control therefore requires identifying the optimal combination of surveillance and intervention (Howe et al., 2013).

The aim of this study was to systematically review the economic criteria and methods used to assess the economic efficiency of animal health mitigation strategies that explicitly included surveillance, by screening peer-reviewed papers and grey literature. This work differs from that of Calba et al. (see the second section of this document) who reviewed the frameworks and methods used for evaluating surveillance as a whole without specifically addressing economic aspects.

2 Materials and Methods

2.1 Literature sources and search strategy

The objective of the search was to identify documents (published articles, conference proceedings, and reports) that present an economic evaluation of an animal health surveillance system. The search query comprised four sections of terms relating to surveillance, animal, health and economic evaluation. The search terms used for each section are summarised in Table 1. Within each section, the terms were linked with the OR conjunction and the four sections were linked with the AND conjunction.

Searching for published papers was done through the Cab Abstract and the Scopus databases which cover around 91% of journals related to veterinary topics (Grindlay et al., 2012). The search was restricted to articles written in English (for reviewing convenience), and published in the last 20 years (since 1993) to focus on up-to-date ideas. All search terms were searched in both the titles and the abstracts. The same search strategy was used for both Cab Abstract and Scopus.

The grey literature, comprising documents such as unpublished papers, reports or conference proceedings, was searched using Google and limited to the 50 first hits with a reduced search query which was defined as follows: (surveillance OR monitor OR monitoring) AND (animal OR livestock OR veterinary OR wildlife) AND (disease OR health OR infection OR outbreaks) AND (economic OR cost OR costs OR benefit OR benefits OR effectiveness). Further, all the proceedings of the Society of Veterinary Epidemiology and Preventive Medicine and of the International Symposium on Veterinary Epidemiology and Economics organised in the last 20 years were also included in the search. These conferences are the two most renowned international conferences on veterinary epidemiology and economics.

Additional articles were searched by screening the reference list of included articles as well as the articles citing the included articles.

Table 1: Terms used for the systematic search of the scientific literature. Asterisks represent wildcards (searches for any word that includes the stem presented).

Section	Search terms
Surveillance	surveillance, monitor*
Animal	animal*, livestock, veterinar*, fish*, wildlife, food system*, herd*, farm*, cattle, cow, cows, bovine, ruminant*, pig, pigs, porcine, swine, sheep, goat*, poultry, bird*, avian, horse*, equine, equid*, cat, cats, dog, dogs
Health	disease*, health, infection*, outbreak*
Economic evaluation	economic evaluation, economic assessment, economic analysis, economic model*, economic value, economic efficiency, cost-benefit, benefit cost, (financial OR cost) AND (evaluation OR assessment OR analysis OR model*), cost-effectiveness, cost-effective, optimisation, maximisation, partial budget, net benefit, gross margin, surplus, net present value, net value, economic impact, efficiency, economic loss, economic benefit, economic cost*, net cost*, direct cost*, indirect cost*

2.2 Study selection and data extraction

The literature selection process is illustrated in Figure 1. First, all the titles and abstracts were screened using the primary exclusion criteria described in Table 2. Full texts of articles that remained were then screened using the secondary exclusion criteria described in Table 2. Because the review explicitly targeted economic evaluations of surveillance, any papers solely evaluating economic aspects of interventions, such as culling, vaccination or treatment, were excluded.

The following information was extracted from the included articles: health condition of interest, species involved, location of the surveillance, surveillance objective, evaluation objective, number of scenarios compared, perspective of the analysis (farm, sectorial or societal level), whether the analysis was *ex-ante* (the analysis targeted hypothetical surveillance systems that might be implemented in the future) or *ex-post* (the analysis targeted only existing surveillance systems), method used to produce epidemiological input (if applicable) and method used for assessing costs, benefits and effectiveness.

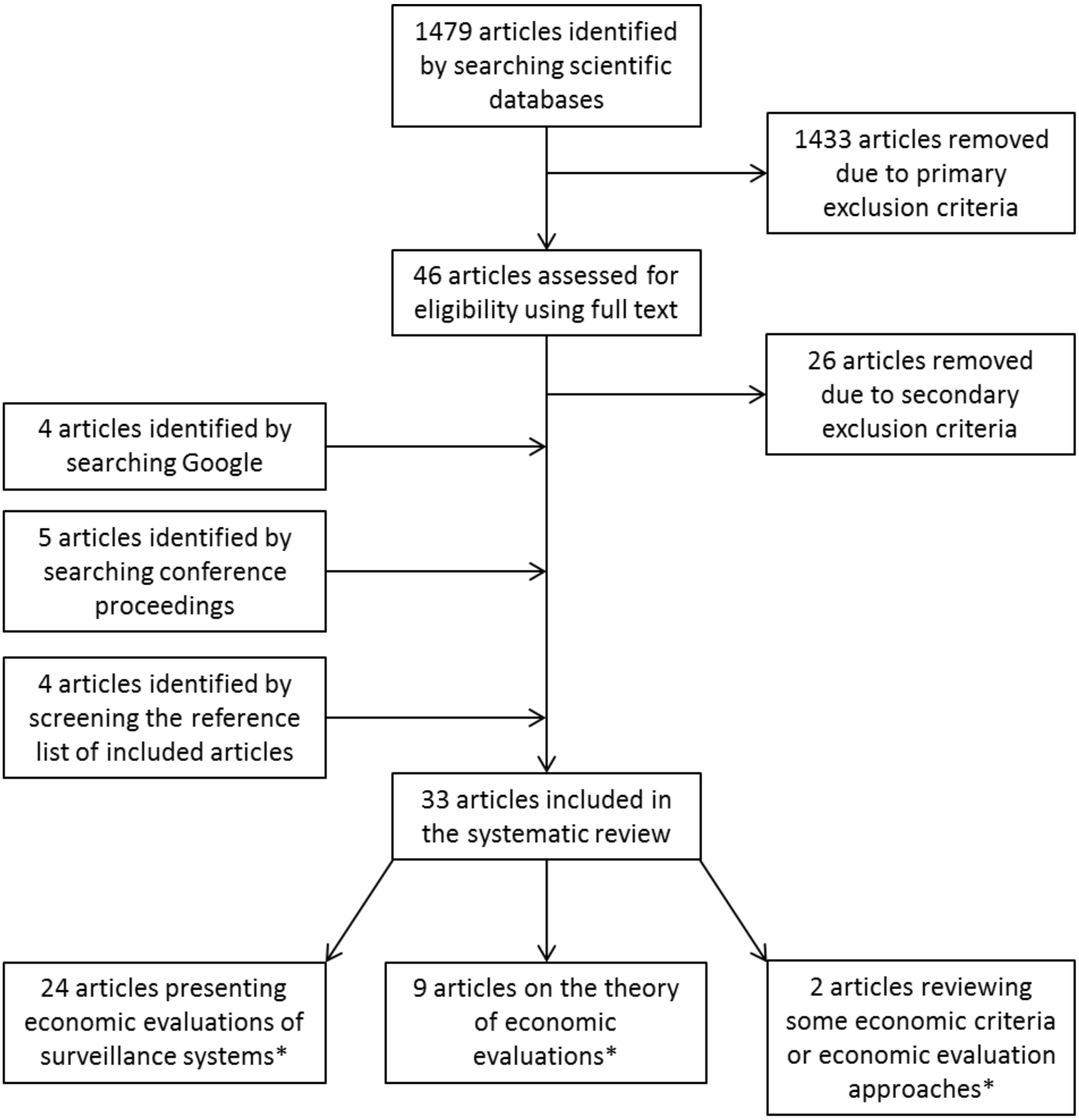

Figure 1: Flow chart of the selection process for the systematic review of economic evaluations of surveillance systems in animal health. *Numbers do not sum to 33 because two articles presented both theory and an application.

Table 2: Primary and secondary exclusion criteria used in the article selection process.

Primary exclusion criteria	The article does not focus on animal health The article does not focus on surveillance as defined for this review The article is only descriptive (historical trend of the disease, pathogenicity…) The article is a general review of a particular disease The article focuses on experimental infections The article is a case report The article focuses on molecular characterizations of a pathogen The article focuses on diagnostic test evaluations The article focuses on the evaluation of vaccine efficacy The article does not involve any economic evaluation or assessment of surveillance
Secondary exclusion criteria	The economic evaluation is focused on the intervention measures rather than on surveillance The article presents a primary exclusion criteria that was not apparent from Title/Abstract

3 Results

The initial search in Cab Abstract and Scopus resulted in a total of 1479 articles. After applying the first exclusion criteria, 46 articles remained. Of these, 26 did not fulfil the secondary exclusion criteria. By examining the reference list of these primary articles, four additional articles were identified. In addition, nine other relevant references were identified in Google and conference proceedings. Therefore a total of 33 articles were included in the review. Of these, 24 presented at least one economic evaluation of animal health surveillance, nine were theoretical articles and two were reviews of evaluation attributes (including economic criteria) or economic evaluation approaches (two articles presented both theory and applications). Figure 1 summarizes the flow of articles during the review.

3.1 Descriptive results

3.1.1 Health condition and species targeted

The 24 articles that described economic evaluations presented 27 case studies. Only three of these applications focussed on a general surveillance perspective encompassing more than one health condition. A total of 20 different health events were evaluated (some surveillance systems focused on several diseases and some diseases were covered by more than one surveillance system). The health events most frequently evaluated included abortions (3/27), foot-and-mouth disease (3/27), bluetongue (2/27), highly pathogenic avian influenza (2/27), salmonellosis (2/27) and paratuberculosis (2/27). The surveillance systems evaluated covered different host species with a large majority of ruminants (16/27) (Figure 2).

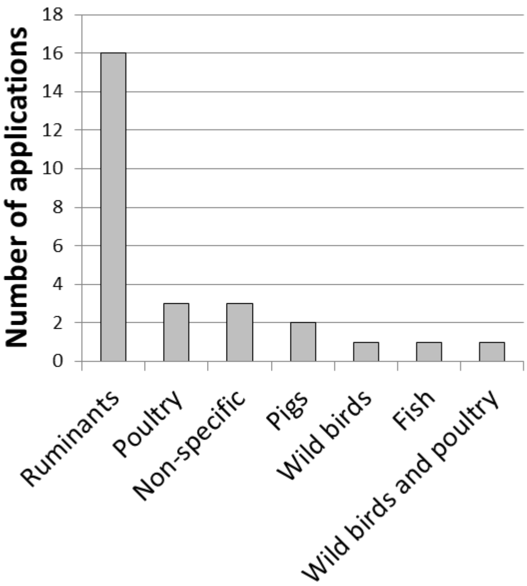

Figure 2: Animal species targeted by the 24 surveillance systems that were evaluated in the papers included in the systematic review.

3.1.2 Area covered by the surveillance system evaluated

There was a wide distribution of areas covered in the economic evaluations in the reviewed articles (Figure 3) with a slight predominance of Switzerland (5/28) and the Netherlands (4/28). One application focused on a surveillance system located in more than one country (Knight-Jones et al., 2010). Most applications were related to surveillance systems implemented in Europe (20/28), followed by North-America (2/28), Africa (2/28), Australasia (2/28) and Asia (1/28).

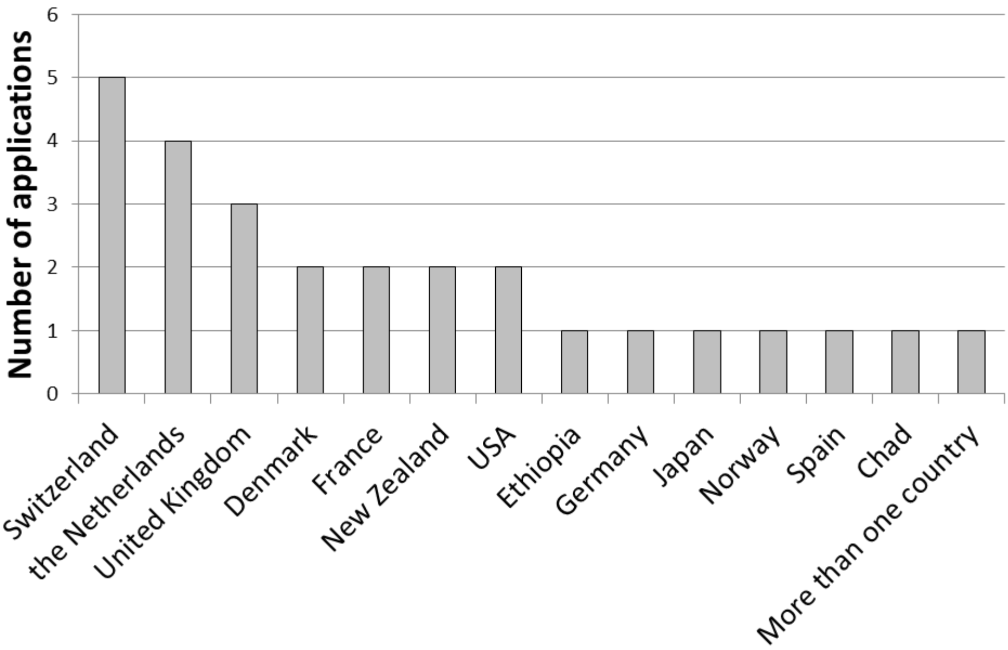

Figure 3: Countries targeted by the 24 surveillance systems that were evaluated in the papers included in the systematic review.

3.2 Evaluation questions

Evaluation questions in the articles included in the review (Table 3) fell broadly into two categories: (*i*) questions aimed at making an economic assessment of an existing surveillance or mitigation program (*ex-post* analyses: seven articles) and (*ii*) questions aimed at assessing a set of alternatives to be able to take a rational decision for implementation in the future (*ex-ante* analyses: 20 articles). Two articles presented both an *ex-post* and an *ex-ante* analysis.

Three types of evaluation question could be identified, namely questions related to the allocation of costs, to the justifiability of surveillance or to the development of improved surveillance. Six applications had a question related to the allocation of costs. For example, Dufour (1999) evaluated the annual operating costs of the RENESA surveillance system for salmonella and mycoplasma contamination in France. Six other papers investigated the justifiability of a surveillance system (as an *ex-ante* or an *ex-post* analysis). As an illustration, Haesler et al. (2012c) investigated whether or not the benefits likely to be derived from the mitigation programme for bovine viral diarrhoea in Switzerland from 2008 to 2017 justified its cost. Finally, the most popular evaluation question related to the identification of the best surveillance system. Indeed, 15 articles related the costs of alternative mitigation programmes to a measure of their outcome (for example its effectiveness) in order to identify the one presenting the best compromise. For example, Rutten et al. (2012) wanted to identify the cheapest sampling strategy among a set of strategies of the same sensitivity for the surveillance of low pathogenic avian influenza in the Dutch egg layer sector.

Table 3: Evaluation questions used in the articles included in the review.

	Evaluation question	References
Ex-post analyses	Was the surveillance/mitigation program in place economically beneficial?	Haesler et al. (2012a, 2012c), Korsgaard et al. (2009), Moran and Fofana (2007)
	How much money did the surveillance/mitigation program cost?	DEFRA (2011), Dufour (1999), Probst et al. (2013)
Ex-ante analyses	Would it be economically justified to implement a given surveillance/mitigation program?	Haesler et al. (2012a), Paisley et al. (2001)
	What would be the cost of alternative surveillance/mitigation programs?	Haesler et al. (2012c), Klinkenberg et al. (2005), Yamamoto et al. (2008)
	Which alternative surveillance/mitigation program is the cheapest given a technical output (i.e. sensitivity)?	Rutten et al. (2012), van Asseldonk et al. (2005)
	Which alternative surveillance/mitigation program is the most beneficial?	Haesler et al (2006), Tambi et al. (2004)
	Which alternative surveillance/mitigation program provides the best compromise between its cost and its effectiveness (technical outcome)?	Dufour (1999), Haesler et al. (2012b), Knight-Jones et al. (2010), Martinez-Lopez et al. (2009), Reber et al. (2012)
	What would be the total cost of a disease according to different mitigation strategies?	Carpenter et al. (2007, 2011), Weber et al. (2008), Elbakidze et al. (2009), Souza et al. (2012)
	How to allocate funds for surveillance between diseases/geographical areas?	Prattley et al. (2007)

3.3 Economic analyses

The investigation of the economic efficiency of present or potential animal health surveillance systems included cost-benefit analyses (CBA), cost-effectiveness analyses (CEA), cost-minimisation analyses and portfolio theory.

3.3.1 Cost analyses

Cost analysis was used in all applications, either on its own (cost evaluation) or associated with the estimation of the effectiveness or the benefits of the surveillance (economic evaluation). Six studies reported on the sole assessment of costs. For example, in 2011, the Department of Environment, Food and Rural Affairs in the United Kingdom analysed the distribution of the veterinary surveillance budget between the different types of surveillance and the different diseases targeted (DEFRA, 2011). Apart from these 6 studies, all other applications related the costs with the outcome of the mitigation strategy either through a cost-effectiveness analysis, a cost-benefit analysis or a cost-minimisation analysis. Around half (14/27) of case studies assessed the cost of only surveillance, the others assessed the cost of the whole mitigation strategy including both the surveillance and the interventions.

Common procedures for assessing the costs of surveillance required a list of all actions that had been (or would be) implemented as part of the surveillance, their frequency and the associated prices. The activities included for assessing the cost of a mitigation strategy (including surveillance and intervention) always encompassed implementation activities such as sampling, laboratory testing or data transfer (Klinkenberg et al., 2005; Rutten et al., 2012). In addition, some articles considered broader costs such as planning activities, labour administrations activities (Häsler et al., 2012a) or labour force costs (Reber et al., 2012). While estimating the cost of existing surveillance activities involved using data from past activities (Dufour, 1999; Probst et al., 2013), estimating the cost of alternative surveillance activities often required output data from epidemiological simulation models, as discussed elsewhere (James, 2009). For example, Yamamoto et al. (2008) conducted their cost-analysis of the surveillance of bovine brucellosis for early detection first by simulating the spread of the disease within and between farms using a dynamic model, and by testing different surveillance strategies on the simulated epidemiological data. This integrated epidemiological model (including spread and surveillance) provided the frequency of all actions that would be implemented according to each surveillance program evaluated, and therefore allowed estimation of their costs.

3.3.2 Cost-effectiveness analyses

Cost-effectiveness analyses were used in eight of the articles reviewed. They assessed the cost of (alternative) surveillance/mitigation programs in relation to their technical outcomes (effectiveness). The type of effectiveness measure selected depended on the context and surveillance objective, which in turn was driven by the mitigation objective. The following effectiveness measures were used in the application studies reviewed: global evaluation score of the surveillance system (Dufour, 1999), probability of introduction or transmission of the disease (Martinez-Lopez et al., 2009; Häsler et al., 2012b), number of infected farms at the end of the epidemic (Van Asseldonk et al, 2005), number of herds detected by the surveillance (Paisley, 2001), and sensitivity of detection (Knight-Jones et al., 2010; Reber et al., 2012; Rutten et al., 2012).

A variety of approaches were used to assess effectiveness. Four applications directly used the outputs of the epidemiological model (including spread, surveillance and potentially intervention) as a measure of the effectiveness of the surveillance (Paisley, 2001; Van Asseldonk et al., 2005; Martinez-Lopez et al., 2009; Reber et al., 2012), two applications integrated a scenario-tree model on the outputs of the simulated disease spread model (Knight-Jones et al., 2010; Rutten et al., 2012), and two applications applied a qualitative assessment based on expert opinion (Dufour, 1999; Häsler et al., 2012b).

Some studies presented cost and effectiveness separately (e.g. van Asseldonk et al., 2005; Reber et al., 2012) while others combined them into a single cost-effectiveness ratio (Martinez-Lopez et al., 2009; Knight-Jones et al., 2010). Two types of cost-effectiveness ratios were used in the applications reviewed: the average cost-effectiveness ratio (ACER) and the incremental cost-effectiveness ratio (ICER). The ACER was considered when no specific surveillance baseline was available; it was computed by dividing the net cost of the surveillance by the value of its effectiveness measure. For example, Paisley (2001) computed the ACER of the surveillance of bovine paratuberculosis in Norway by dividing the total cost of the surveillance by the number of infected herds that would be detected by the surveillance. On the other hand, the ICER was used to compare an alternative surveillance strategy with a baseline surveillance strategy (this baseline strategy can be an existing surveillance strategy or a "no-action" strategy). It was computed by dividing the difference in costs between strategies by the difference in effectiveness. For example Martinez-Lopez et al. (2009) used the ICER to compare the Spanish surveillance strategy in place to detect Aujeszky's disease with three alternative surveillance strategies.

3.3.3 Cost-benefit analyses

Six studies reported the results of a cost-benefit analysis. Benefits from a surveillance system were commonly defined as the costs estimated to have been avoided as a result of the implemented mitigation strategy (including the surveillance strategy of interest). They were computed as the difference in disease costs between the scenario with the mitigation strategy in question and a baseline scenario. In most studies, the baseline scenario was a scenario with no mitigation strategy (neither surveillance nor intervention) in place (Paisley, 2001; Tambi et al., 2004; Häsler et al., 2006; Moran and Fofana, 2007; Korsgaard et al., 2009; Häsler et al., 2012c). However, for evaluating the surveillance of bluetongue in Switzerland, Häsler et al. (2012a) used as a baseline scenario a mitigation strategy based on voluntary participation of the farming sector. In all the cost-benefit analyses reviewed, outcomes were reported either as benefit-cost ratios and/or net present values. Because either the baseline scenario or the scenario with the mitigation strategy in question is unobserved, conducting cost-benefit analyses always required simulations.

In the applications that focussed on animal-specific diseases, a variety of types of loss avoidance were considered for estimating the benefits. All applications included a sectorial perspective of the disease costs taking into account the expenditures related for example to mortality, abortions, palliative treatments, laboratory testing and movement bans (Häsler et al., 2012c). In addition to these sectorial disease costs, two applications included a societal perspective using economic surplus methods for taking into account costs related to consumer responses to disease outbreaks, loss of export earnings and change of the market price (Tambi et al., 2004; Moran and Fofana, 2007). One paper adopted a public health perspective for estimating the benefits of the surveillance of salmonella in the layer poultry sector in Denmark (Korsgaard et al., 2009): they estimated the costs of a human salmonellosis by assessing the costs of health care and lost labour and related these costs to the number of egg-associated cases that were avoided due to the mitigation strategy in the poultry sector.

3.3.4 Other economic analyses

In two *ex-ante* analyses, Prattley et al. (2007) used the portfolio theory concepts (widely used in finance) coupled with a risk-based approach for distributing surveillance resources between different exotic diseases to detect their potential introduction, and on a spatio-temporal basis for detecting exotic causes of ovine abortion.

Five application studies reported the results of cost-minimisation analysis (Carpenter et al., 2007; Weber et al., 2008; Elbakidze et al., 2009; Carpenter et al., 2011; Souza Monteiro et al., 2012). In each application, the total expected costs of the diseases were estimated by summing all types of monetary losses incurred by a disease including the costs related to mitigation programs. All of these applications compared the total costs of different mitigation programs in order to identify the one which ends up with the lowest total costs. The general principle of cost-minimisation analyses is very similar to the principle of cost-benefit analyses: while cost-benefit analyses intend to maximize the difference between the losses avoided by the mitigation (the losses incurred by the disease given there was no mitigation minus the losses incurred by the disease given the mitigation) and its costs, a cost-minimisation analysis aims to minimise the sum of the costs of the mitigation and the losses incurred by the disease given mitigation. However, a cost-minimisation analysis cannot determine whether or not a mitigation strategy is economically beneficial since it estimates a total cost rather than a net benefit. All applications included losses related to surveillance and intervention costs (for example slaughter or vaccination costs). In addition to these direct primary losses and similar to some cost-benefit analyses (see previous paragraph), Souza Monteiro et al. (2012) included production losses and costs due to movement restrictions, and Carpenter et al. (2011) also took into account losses due to change of the market price.

4 Discussion

The small number of papers included in the review clearly confirms that economic evaluation of disease surveillance systems is still rarely used in the context of animal health (Rich et al., 2005). This scarcity of economic evaluations may be linked to the rarity of robust and validated economic evaluation frameworks for animal health surveillance. Even though a few frameworks have been proposed (Karesh, 1993; Häsler et al., 2011c; Scott et al., 2012; Howe et al., 2013), standardisation of approaches and reporting is lacking. On the contrary, in the public health domain, efforts have focused on the development of standardised approaches for the economic evaluation of health interventions and reporting of the results thereof (Husereau et al., 2013). This lack in standardisation is reflected in the heterogeneity of approaches and outcome measures used. For example, unlike in public health economics where the metrics disability-adjusted life years (DALYs) and quality-adjusted life years (QALYs) are validated and standardised measures for a non-monetary benefit, there are no similar measures available in animal health (Dehove et al., 2012). This hinders the comparability between studies, systems and countries and therefore limits the allocation of resources to surveillance systems that are most cost-effective. It is recommended to develop a set of internationally recognised and standardised effectiveness measures for animal health surveillance for inclusion in CEA.

The cost-benefit outputs are useful when one is able to translate the outcome of the surveillance into monetary terms. Cost-benefit analyses can produce three common outputs: the benefit-cost ratio, the net present value and the internal rate of return (Rushton et al., 1999; Rich et al., 2005). It is striking that to date only the two first ones were applied in the context of the surveillance of animal health: the benefit-cost ratio was used as an acceptability criterion to investigate whether the benefits justified the costs (Moran and Fofana, 2007; Korsgaard et al., 2009) and the net present value as an acceptability criterion as well (Moran and Fofana, 2007) but also as an optimizing criterion to identify which surveillance strategy produces the highest net benefits (Häsler et al., 2011a; Häsler et al., 2012a). The internal rate of return, which estimates the effective interest rate earned on the activity, appears to not yet have found an application in animal health surveillance.

In all the applications that aimed to identify the most suitable mitigation strategy, the number of surveillance strategies was always finite, and the different protocols for these surveillance strategies always defined *a priori*. By just looking at a finite number of alternative mitigation strategies, it is unlikely to identify the strategy where the net benefit for society is the highest (or the total costs of a disease are the lowest) since the best mitigation strategy can be different from the few that are evaluated. To identify such an optimal strategy, a continuous range of mitigation options should be assessed. In practice, this would require some form of mathematical programming applied to identify the optimal strategy over a continuous range of mitigation strategies (Rushton et al., 1999). Doing so would require defining an objective function whose output (for example the net expected cost incurred by a disease) would be dependent on a set of surveillance and intervention parameters coupled with monetary values. As proposed in ecology for the control of invasive species (Hauser and McCarthy, 2009; Moore et al., 2010), optimizing this objective function would identify the parameters of the optimal mitigation strategy. To date, such approach is clearly underused in the context of animal health to identify an optimised surveillance strategy. Only one application (Kompas et al., 2006) is known by the authors although it did not come out from the search of the grey literature performed for this systematic review. The most likely reason of this underuse may be the complexity to formalise the objective function which can end up being very difficult to solve analytically (Rushton et al., 1999; Kompas et al., 2006).

No economic evaluations examined the economic efficiency of the global surveillance system of a country or region as a whole. Neither did any attempt to compare surveillance systems for different diseases, or to examine in detail infrastructure or fixed costs, or to address the value of One Health surveillance systems at national or international level. Further, none of the studies took into account the wider animal health or food system as a whole. For example, livestock value chain analysis in combination with risk analysis provides a framework to assess risk factors in the value chain, such as structures of power, economic profitability of certain activities or the stability of the food chain (FAO, 2011). Data collection of key indicators in such systems would help to monitor changes in health-related events such as changes in livestock population densities or demand for livestock products. To date, surveillance systems have rarely taken into account processes at food system or livestock sector level that impact on disease risk. This is most likely due to the historical focus of surveillance which is disease-centred rather than people-centred and thereby commonly focusing on the populations at risk of disease rather than on the population at risk of economic losses. This disease-centric approach is reflected in the range of journals in which the applications were published: the three most popular journals were Preventive Veterinary Medicine (50% of the papers included in the review), Epidemiology and Infection (15%) and Veterinary Research (10%). With the increasingly popular One Health and EcoHealth thinking, it is advised to consider disease surveillance and its economic evaluation from a systems perspective rather than a single sector perspective, as has been suggested previously for zoonotic diseases (Zinsstag et al., 2007).

For simplicity and because most scientific papers are published in English, it was decided to restrict the search to only papers written in English. In so doing we acknowledge the omission of some papers written in other languages. Because the English-written criterion was specified directly in the database search queries, the number of articles written in other languages but which could have been of interest for the review is unknown. The paper by Ouagal et al. (2012) was the only paper not written in English that was identified by the search. It happened so because the abstract was written in English. This paper estimated the cost of the epidemiological surveillance network for animal diseases in Chad (Ouagal et al., 2012). Papers presenting economic analyses of only intervention measures were much more often encountered than papers including surveillance strategies as part of the evaluation. Due to the interconnected nature of surveillance and intervention (Häsler et al., 2011b), it was sometimes difficult to choose whether or not to include an article given it presented surveillance as an integrated part of a mitigation programme, but did not report the economic evaluation of surveillance as an explicit element of the analysis. For example, Gunn et al. (2008) performed a cost-benefit analysis of alternative mitigation strategies for bluetongue virus in Scotland depending on different incursion scenarios. But because the alternative mitigation strategies included only alternative vaccination strategies rather than alternative surveillance strategies, this article was not included in the review. Screening the abstract of the papers that were excluded based on this criterion did not reveal the presence of economic approaches different from those picked up by the included articles. Although economic evaluations of intervention strategies are valuable for informing decision makers about which strategy to adopt, integrating surveillance as part of the mitigation strategy (in addition to interventions) in order to optimise the whole mitigation strategy would be very valuable (Howe et al., 2013).

5 Conclusions

Animal health surveillance has recently evolved from basic concepts to more sophisticated approaches (Stärk et al., 2006; Dorea et al., 2011), from local concerns to global perspectives (Perez et al., 2011), and from practical decisions to economically-driven decisions (Rushton et al., 1999; Otte and Chilonda, 2000).With increasing financial constraints in animal health and related services, this last aspect is more pressing than ever, since all government spending has to be justified. This explains partly the increasing research in animal health economics over the past two decades and the related advancement of the field (Rushton, 2009). Although still low, the emergence of studies interested in the economics of surveillance during the last decade is an encouraging sign for a shift in thinking towards a systematic way of including economics in surveillance decisions.

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Section 2: Guidelines, frameworks, methods and tools for the evaluation of surveillance systems: a systematic review

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Abstract

In the last ten years, investment and interest in animal disease surveillance systems (SS) have increased due to events such as the BSE crisis and concerns about the risk of an avian influenza pandemic. It is essential to have timely and relevant evaluations of surveillance systems, in order to improve their fitness performance and cost-effectiveness. To address these points, several organizations have developed evaluation frameworks and guidelines.

In order to identify and compare their advantages and limitations, we implemented a systematic review using PRISMA guidelines (primary search n = 521 records). After applying exclusion criteria and identifying other additional pertinent documents via citations, 15 documents were retained. These were analysed in detail regarding the area and the type of SS targeted; the kind of evaluation; the development process; the objectives; the method applied to conduct the evaluation and its outputs; and the validation of the evaluation method implemented.

Most of the identified frameworks and guidelines were general and provided recommendations for global evaluations. Several common steps for the evaluation process were identified: (1) defining the SS under evaluation, (2) designing the evaluation process, (3) implementing the evaluation, and (4) drawing conclusions and recommendations. Out of the 15 evaluation processes identified, 13 used attributes (11) or criteria (2) to assess SS performance. However; a lack of detail regarding the methods and tools to implement attribute assessment was highlighted.

1 Introduction

The expansion of the concept of surveillance and the development of many different surveillance systems (SS) has increased since the twentieth century (Declich and Carter 1994). These systems are developed in different fields, either public health, animal health, environmental health, or more recently combining these sectors in a One Health approach. Since the last decade, investment and interest in SS have increased due to events such as the SARS epidemic in 2003, or concerns about Avian Influenza pandemic (Shahab 2009). A wide diversity of these systems can be actually seen, e.g. depending on the disease or condition under surveillance, the objectives of the system, the sources of data (such as slaughterhouse, private clinics), the method of data collection (active, passive, syndromic, and so on), (Declich and Carter 1994).

Even if the needs for effective SS have long been recognized, there is an increased international pressure to improve the efficiency of SS even further. Indeed, changes in the global disease environment lead to public health and food security challenges for human populations worldwide and highlight the importance of having efficient surveillance systems (Granger 2011). Increasing animal diseases surveillance and improving the efficiency of SS would limit disease consequences on agriculture, human health, and local and national economies (Granger 2011). But at the same time public veterinary services are dealing with important budget reduction, bringing the need for more effective surveillance strategies and sustaining only the most relevant systems (Stark, Regula et al. 2006).

In the field of animal health, the efficiency of SS has a direct impact on the improvement of production and food security, the economic development and the access to international trade. Moreover, around 75% of emerging infectious diseases in humans are zoonoses (Granger 2011). Therefore the capacities of SS to accurately describe patterns of animal diseases is of public health importance, and it is critical to have timely and relevant evaluations of these systems in order to improve their performance and cost-effectiveness (Shahab 2009). Evaluation is defined as the systematic and objective assessment of the relevance, adequacy, progress, efficiency, effectiveness and impact of a course of actions, in relation to objectives and taking into account the resources and facilities that have been deployed (WHO, undated). To ensure quality of these systems, there is a further need to design comprehensive, timely, effective and affordable evaluation frameworks. Depending on epidemiological, sociological and economic factors, animal diseases surveillance systems can be complex, as is the choice of attributes to describe them and therefore the choice of methods and tools to evaluate them. In this context, 'attributes' is used to refer to the many quantifiable characteristics of surveillance systems (Drewe, Hoinville et al. 2013).

The aim of this systematic review is to identify and to analyse the existing frameworks, guidelines, methods and tools developed to describe and estimate the performance of health SS. The objective is to identify their advantages and limits, in order to identify possible ways of improvement by highlighting the main components of an evaluation. This information will be further used to develop a practical tool for the evaluation of SS irrespective of epidemiological context and adapted to decision-makers.

2 Material and methods

2.1 Literature sources and search strategy

According to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) requirements, a systematic literature search was conducted using CAB abstract, Web of Science, Medline, and Scopus to identify articles. The literature search focused on the papers published between 1992 to the beginning of 2013. It was restricted to the English language, and to articles with available abstracts. Four domains were associated for the search, with several keywords for each, due to the large diversity in the terminology used: surveillance ("surveillance or report* or monitor*"), evaluation ("evaluat* or assess* or analys*"), framework ("framework or guideline or method* or tool"), and health ("health or bioterrorism or public security").

An additional search was done using Google Scholar in order to identify any other relevant documents. Four search algorithms were used, targeting the same domains as the previous search:

- ["health information system" OR "health surveillance" OR "health information network"] + “evaluation guidelines” + [methods OR tools]
- ["health information system" OR "health surveillance" OR "health information network"] + “evaluation framework” + [methods OR tools]
- ["health information system" OR "health surveillance" OR "health information network"] + “assessment guidelines” + [methods OR tools]
- ["health information system" OR "health surveillance" OR "health information network"] + “assessment framework” + [methods OR tools]

Some exclusion criteria were directly used during this second search process: “surgical procedures”, “drug treatment”, “risk management”, “risk analysis”, cancer, “clinical trial”, and “risk assessment”.

Additionally, some other documents were identified from the references of included articles.

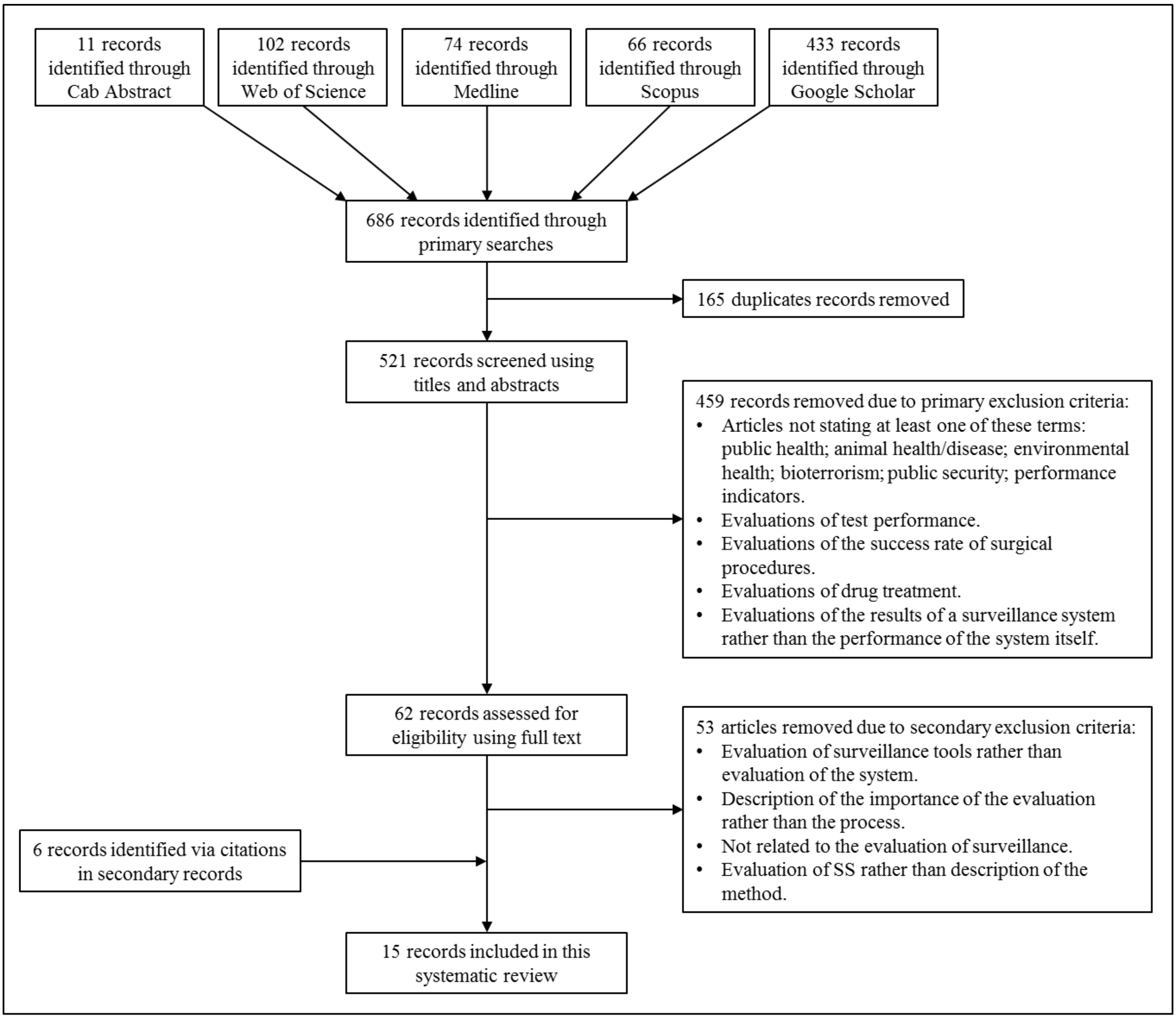

Figure 1: Flow chart diagram of studies selection process to include in the systematic review

2.2 Study selection and data extraction

As illustrated in Figure 1, the literature retrieval process was done through two screening phases. For the first screening, five primary exclusion criteria were applied to the titles and abstracts: articles not stating at least one of the following terms (public health, animal health/disease, environmental health, bioterrorism, public security, performance indicators) (1); articles describing evaluations of test performance (2), success rate of surgical procedures (3), drug treatment (4), and results of a SS rather than the performance of the system itself (5). After obtaining the full texts of these articles, four secondary exclusion criteria were applied: articles related to the evaluation of surveillance tools rather than evaluation of the system (1), articles describing the importance of the evaluation rather than the evaluation process (2), articles not related to the evaluation of surveillance (3), and articles describing results from an evaluation rather than describing the method (4).

Relevant data were extracted from the identified articles related to: the area and the type of SS targeted; the type of evaluation proposed; the development process; the objectives of the evaluation; the methodology proposed to conduct the evaluation and its outputs; and the validation of the evaluation method developed.

3 Results

The literature search identified a total of 521 records (Figure 1), three were not available and have been excluded: Yoshimizu et al, 2001; Solberg, 1999; Teutsch et al, 2000. The remaining articles were screened for this review; after applying exclusion criteria and identifying other records via citations, a total of 15 records remained (Figure 1, Table 1). Data from these records were extracted and included in this review.

3.1 Area and type of surveillance targeted

Within the identified documents, ten approaches were developed in the field of public health: WHO (2011, 2008, 2006, 1997), Meynard et al (2008), ECDC (2006), Buehler et al (2004), HSCC (2004), KTL (2004), and German et al (2001); three in the field of animal health: SERVAL (Drewe et al, 2013), and OASIS (Hendrikx et al, 2011), Critical Control Points (CCPs) (Dufour, 1999); one in environmental health: Malecki et al (2008); and one in both field of animal and public health: El Allaki et al (2012).

3.2 Type of evaluation proposed

Different types of evaluation approaches were described in the selected literature: guidelines, frameworks, methods or tools. Guidelines can be defined as "a statement or other indication of policy or procedure by which to determine a course of action"; framework is more considered as "a structure for supporting or enclosing something else, especially a skeletal support used as the basis for something being constructed"; a methodology is defined as "a body of practices, procedures, and rules used by those who work in a discipline or engage in an inquiry; a set of working methods"; tools are "anything used as a means of performing an operation or achieving an end" (http://www.thefreedictionary.com/).

Within the identified documents, two were defined by the authors as guidelines (German, Lee et al. 2001; WHO 2006); seven as frameworks (WHO 1997; Buehler, Hopkins et al. 2004; HSCC 2004; ECDC 2006; Malecki, Resnick et al. 2008; Meynard, Chaudet et al. 2008; Drewe, Hoinville et al. 2013); two as methods (Dufour 1999; El-Allaki, Bigras-Poulin et al. 2013); and four as tools (KTL 2004; WHO 2008; Hendrikx, Gay et al. 2011; WHO 2011). Only two of these papers proposed ready-to-use tools: OASIS (Hendrikx, Gay et al. 2011) and IPCAT-N and IPCAT-H (WHO 2011). In order to summarize all these terms, we will define these types of evaluation as evaluation approaches in the review.

3.3 Development process

The evaluation approaches were developed by several kinds of organizations, in different contexts and using different development methods (Table 1).

The development processes were clearly described in only four out of the 15 documents: SERVAL (Drewe et al, 2013), OASIS (Hendrikx et al, 2011), Malecki et al (2008) and CCPs (Dufour, 1999). Two of these evaluation processes were developed using expert opinion: SERVAL framework was developed by 16 surveillance experts, and reviewed by 14 other experts. CCP method (Dufour, 1999) was developed using the Hazard Analysis Critical Control Point method (HACCP), and submitted to a panel of experts using a consultation method called Delphi. OASIS was developed based on three assessment methods (CCP, and CDC and WHO guidelines). Malecki et al used results from a stepwise review to identify indicators models and examine criteria used in environmental health. In this paper, they defined indicators as elements providing quantitative summary measures and descriptive information; they are derived from surveillance and monitoring data (Malecki, Resnick et al. 2008).

The other evaluation approaches proposed in the literature were not describing the development process, except in Meynard et al where they explained that the proposed evaluation framework (targeting military surveillance) was based on CDC guidelines to evaluate syndromic surveillance.

3.4 Objective(s) of the evaluation

According to the area and to the type of surveillance, several objectives were identified (Table 1). Some identified objectives were to assess the effectiveness of SS by identifying its strengths and weaknesses (SERVAL; OASIS; German et al, 2001; HSCC; WHO, 1997; WHO, 2006; Dufour, 1999). Some were designed to guide the implementation of efficient SS providing valuable data (Malecki et al, 2008; WHO, 2011; WHO, 2008; Maynard et al, 2008; KTL, 2004; ECDC, 2006).

Table 1: List of the evaluation approaches developed for the evaluation of surveillance systems, with the type and name of organisation having developed them, the development context, the area of surveillance, the type of document and the objectives of the evaluation stated in the document.

References	Type and name of the organisation(s)	Context	Area of surveillance	Type of document	Objective(s) of the evaluation as stated in the document
Drewe et al, 2013	University Government organisation RVC – SAC AHVLA	Funding provided by the government	Animal health	Framework	Support the detection of disparities in surveillance and support decisions on refining SS design
El Allaki et al, 2012	University Faculty of veterinary medicine	NA	Animal and public health	Method	Evaluate the completeness and coherence of the concepts underlying a health surveillance program as compared to a theoretical standard
Hendrikx et al, 2011	Government Organisation ANSES	NA	Animal health and food safety	Tool	To propose recommendation for improvement of SS
WHO, 2011	International Organisation WHO	NA	Public health	Tool	Help plan, organize, implement SS
Malecki et al, 2008	Gov. Organisation University DHS – DPH – BEOH School of Public Health	Funding from the CDC and PNEPH tracking programs	Environmental health	Framework	Make evidence-based decisions regarding the future selection, development and use of data
WHO, 2008	International Organisation WHO	NA	Public health	Tool	To establish a baseline and to monitor progress
Maynard et al, 2008	Institut Pasteur* University	NA	Public health	Framework	To develop a secure architecture for the recording, notification and analysis of information

WHO, 2006	International Organisation WHO	Funding from USAID	Public health	Guidelines	To establish and maintain effective and efficient surveillance and response systems
ECDC, 2006	European Organisation ECDC	Funding from the European Commission	Public health	Framework	To provide objective, valid and reliable information for the decisions on which surveillance activities and functions should be continued
Buehler et al, 2004	Government Organisation CDC	NA	Public health / Early detection	Framework	To establish the relative value of different approaches and to provide information needed to improve their efficacy
HSCC, 2004	Government Organisation HSCC	Developed for Health Canada	Public health	Framework	To assess the quality of the information provided; the effectiveness in supporting the objective(s), in supporting informed decision-making; and the efficiency of SS
KTL, 2004	Government Organisation KTL	Developed for EU	Public health	Tool	To assess whether the surveillance method appropriately addresses the disease/health issues; whether the technical performance is adequate
German et al, 2001	Government Organisation CDC	NA	Public health	Guidelines	To define how well the system operates to meet its objective(s) and purpose
Dufour, 1999	ENVA	NA	Animal health	Method	To contribute to the improvement of the management of epidemiological animal health SS
WHO, 1997	International Organisation WHO	NA	Public health	Framework	To assess existing SS and identify areas which can be improved

3.5 Description of the method and outputs

Eleven approaches are described in details with their process structured around 3 to 6 steps: (Table 2). These steps differ by field of surveillance (public health, animal health, environmental health), by approach type (guidelines, framework, method or tool) or by objective(s). Nevertheless, four common stages in the evaluation can be identified: (1) defining the SS under evaluation, (2) designing the evaluation process, (3) implementing the evaluation, and (4) drawing conclusions and recommendations.

The formats of the approaches vary from general roadmaps (German, Lee et al. 2001; Buehler, Hopkins et al. 2004; ECDC 2006; Malecki, Resnick et al. 2008; Meynard, Chaudet et al. 2008; El-Allaki, Bigras-Poulin et al. 2013), to structured roadmaps (WHO 1997; HSCC 2004; KTL 2004; Dufour 2005; WHO 2006; WHO 2008; Drewe, Hoinville et al. 2013), with some providing associated questionnaire (KTL 2004; Dufour 2005; Hendrikx, Gay et al. 2011), scoring guide (Dufour 2005; Hendrikx, Gay et al. 2011), and/or worksheets (Hendrikx, Gay et al. 2011; WHO 2011).

Out of the 15 approaches, only 5 specify the targeted evaluators and the specific knowledge required to perform such evaluations (WHO 1997; KTL 2004; ECDC 2006; Drewe, Hoinville et al. 2013, Hendrikx, Gay et al. 2011).

A total of 47 distinct attributes were considered in the 15 evaluation approaches (Annex 1), but most of the evaluation approaches do not provide real methods or tools to implement the assessment (13 out of 15). SERVAL framework provides a matrix selection grid; OASIS and WHO (2008 and 2011) propose a finalised tool but with limited information on the way the attributes are being measured (Table 2) (Drewe, Hoinville et al. 2013; Hendrikx, Gay et al. 2011 ; WHO 2008; WHO 2011). Seven of these documents provide definitions of the selected attributes (WHO 1997; German, Lee et al. 2001; Buehler, Hopkins et al. 2004; HSCC 2004; WHO 2006; Meynard, Chaudet et al. 2008; Drewe, Hoinville et al. 2013). Some approaches suggest ways on how to handle the assessment phase, by providing examples of questions to be asked to key stakeholders of the SS, or by providing references to publications related to the evaluation of SS and to existing methods and tools.

Three evaluation tem allow the evaluator to compute visual representations of the results (diagram, radar chart, etc.)(WHO 2008; Hendrikx, Gay et al. 2011; WHO 2011). In the majority of the cases (12/15), the main outputs of the evaluation process are given in the form of a report, or a communication, describing the findings and the recommendations to improve the SS.

Table 2: List of the approaches developed for the evaluation of surveillance systems, the steps to conduct evaluation and the related attributes and outputs.

Reference	Steps	Organisation	Evaluators	Structure	Attributes				Outputs
					Number	Definitions	Methods / tools	Selection process	
Drewe et al	Scope of evaluation SS characteristics Design the evaluation Conduct the evaluation Report	Structured roadmap and application guide	People familiar with epidemiological concepts	Data collection Data management Data analysis Data dissemination	22	Yes	No	Yes	Qualitative Report
Malecki et al	Priority setting Scientific basis and relevance Analytic soundness and feasibility Interpretation and utility	General roadmap	Not specified	-	44	No	No	No	Not specified
Meynard et al	Initial evaluation Intermediate evaluation Final evaluation	General roadmap	Not specified	-	21	Yes	No	No	Conclusions and recommendations
ECDC	Usefulness of the activities and outputs Technical performance Fulfilment of contract objectives	General roadmap	Evaluation team with experts	-	8	No	No	No	Report of recommendations
Buehler et al	System description Outbreak detection System experience Conclusions and recommendations	General roadmap	Not specified	Purpose of the system Stakeholders Operation	10	Yes	No	No	Reports of recommendations
HSCC	Context of the SS Evaluation questions Process for data collection and management Findings Evaluation report Following up	Structured roadmap	Not specified	Purpose Roles and responsibilities Design and scope Risks and issues	13	Yes	No	No	Report of recommendations
WHO (1997)	Preparation for the evaluation Documentation and evaluation of	Structured roadmap	Ministry of Health	Responsibilities for surveillance Disease surveillance	14	Yes	No	No	Report of recommendations

	the SS Evaluation of the capacity of the SS Outcome of the evaluation			Vertical programmes Donor-run programs Health information system Programmes of eradication Other					
WHO (2006)	Plan to evaluation Prepare to evaluate Conduct the evaluation Dissemination and use of the results	Structured roadmap	Not specified	Legislation for surveillance Surveillance strategy Implementers and stakeholders Networking and partnerships	10	Yes	Examples	No	Report of recommendations
German et al	Engage the stakeholders Describe the SS Evaluation design Performance of the SS Conclusions and recommendations Findings and lessons learned	General roadmap	Not specified	Public health importance Purpose and operation of the SS Resources used	10	Yes	No	No	Report of recommendations
El Allaki et al	Text analysis Program conceptual model Comparison Validation	General roadmap	Not specified	-	0	-	-	-	Report of recommendations
Dufour	Description of the SS Identification of the priority objectives Building of dashboard and indicators Implementation and follow-up Updates and audit	Structured roadmap, questionnaire and scoring guide	Not specified	General Aims Sampling Environmental factors Screening and diagnostic Collection and circulation of data Data processing and analysis Dissemination of information	8*	No	No	No	Not specified
Hendrikx et al	Design the evaluation Implement the evaluation Finalisation	Questionnaire, scoring guide and worksheets	Collaboration between evaluation expert and SS coordinator	Objectives and scope Institutional organization Diagnostic laboratory Surveillance tools Surveillance procedures Data management Training Restitution and diffusion of information	10 (+8*)	No	No	No	Diagrams, histograms, radar chart Report of recommendations
WHO (2011)	-	Worksheets (checklist)	Not specified	Organisation Technical guidelines Human resources	0	-	-	-	Tables, radar charts

				Surveillance Microbiology laboratory support Environment Monitoring and evaluation Link with public health and other services					
WHO (2008)	Resources assessment Indicators Data sources assessment Data management assessment Data quality assessment Information dissemination and use	Structured roadmap and application guide	Not specified	Coordination Financial and human resources Infrastructure	0	-	-	-	Scores, graphs, report of recommendations
KTL	Usefulness of the operation Quality of the outputs Development of the national SS Technical performance Structure and management	Structured roadmap and questionnaire	External and independent evaluators	Web site Resources, data protection and administration Management Decision making Costs	6	No	No	No	Reports on the findings

* Criteria

3.6 Case studies

Studies on the evaluation of SS have been well reviewed recently by Drewe et al (Drewe, Hoinville et al. 2012). Here we concentrate on the applications providing validation of the evaluation approaches described in this review.

Some evaluation approaches have been validated through case studies that are directly described in the corresponding publication: SERVAL (Drewe et al, 2013), El Allaki et al (2012), OASIS (Hendrikx et al, 2011), and Dufour et al (2005). Some approaches were developed using case studies: Malecki et al, Maynard et al. For the others, applications can be found in the literature, especially for the CDC guidelines (German et al, 2001) which remains the main guidelines used for evaluation. Indeed, in a recent review of the evaluation of SS almost a quarter of the identified applications (23/99) used attributes recommended in the CDC guidelines (Drewe, Hoinville et al. 2012).

The SERVAL framework was tested by applying it to three surveillance systems with various objectives: demonstration of freedom, surveillance for endemic disease, and surveillance for early detection of an exotic disease. The application to surveillance for endemic disease is illustrated in the online document: www.rvc.ac.uk/VEEPH/documents/SERVAL.pdf., which describe the evaluation of the tuberculosis surveillance system of cattle in Great-Britain. In this report, no information related to the methods or tools used for the assessment of the selected attributes is described. However, the authors provide a description of the attributes and the associated recommendations for improvement.

The evaluation approach developed by El Allaki et al (2012) was applied to a public health surveillance program, which was designed to understand better enteric disease epidemiology in Canada. The objective of the field application was to illustrate the feasibility and utility of the evaluation. In order to carry out an evaluation using this conceptual model, a technical team member who will provide documents describing the system is required. Moreover, technological support is requested for the analysis of these documents, and for the elaboration of the conceptual model. This case study is detailed in the document through: *(i)* summary of the results, *(ii)* list of documented concepts, and *(iii)* list of non-documented concepts. Finally, the evaluation lead to the identification of absent key concepts after a first interview of 1.5 hours, two steps for running the software during 5 days each, and a presentation of the results of 2.5 hours.

The OASIS evaluation tool was applied to five case studies, only the application to the surveillance network for antimicrobial resistance in pathogenic bacteria from animal origin (RESAPATH) was described in the document. OASIS was applied by two members of the working group involved in the coordination of the SS. It took two days to complete the questionnaire and to score the criteria. Within this approach, evaluation criteria are covering the context and operational process a SS (Hendrikx, Gay et al. 2011). The tool provides three outputs which are presented in this documented case study. Interpretation of results is provided as possible ways of improving the system.

Dufour et al (2005) tested their CCP method on two SS: RENESA (evolution of mycoplasmosis and salmonellosis rates in poultry) and the foot and mouth disease surveillance French network in cattle. Results are provided in the guide with the associated recommendations provided to stakeholders. There is no description on how the work was implemented, but questionnaires and guidance notes are provided in an annex of the book.

The updated guidelines from the CDC working group (German et al, 2001) have been widely used for the evaluation of SS. These guidelines were mostly used for the identification of attributes to assess, and only few attributes are assessed (Drewe, Hoinville et al. 2012). An example of CDC guidelines (German et al, 2001; Buehler et al, 2004) application was for the evaluation of the Australian Sentinel Practice Research Network (ASPREN) surveillance for influenza-like illness (ILI) (Clothier, Fielding et al. 2005). The objective of this evaluation was to assess the utility of the SS. The evaluation lasted 4 months and looked at specific attributes: simplicity, flexibility, acceptability, timeliness, stability, data quality, usefulness and representativeness. Informal interviews were implemented, as well as postal survey, data analysis and review of reports for the evaluation. The results from the qualitative assessment of the selected attributes are presented in the report, which provides recommendations for improvement of the system as well. Nonetheless, there is no information related to the type of evaluator or regarding the followed guidelines.

Guidelines developed by WHO in 2006 were validated during the evaluation of Aboriginal Community-Centered Injury Surveillance System (ACCISS) and two institution-based systems (Auer, Dobmeier et al. 2011). The evaluation team considered some of the SS attributes of the quality of the SS (i.e. simplicity, flexibility, acceptability, etc.) and surveillance process (i.e. data collection, analysis, etc.). Document review, focus groups, and individual interviews were implemented for data collection. These validation studies highlighted limits in this approach linked to the fact that WHO guidelines were disproportionately focused on data collection instruments and surveillance functions largely associated with data collection (Auer, Dobmeier et al. 2011). When the objective of the evaluation is to ensure that knowledge gained through surveillance is translated into action, the WHO guidelines do not seem to be relevant and would need to be re-conceptualized as it otherwise emphasizes epidemiologic attributes. An interesting findings suggest that acceptability is an underpinning attribute of a good SS (Auer, Dobmeier et al. 2011).

4 Discussion

4.1 Several evaluation levels

The terminology used to describe the evaluation approaches varies in the identified documents. Some are defined by their authors and presented in this review as frameworks, some others as guidelines, methods or tools. However, this review highlights the overlaps between the different types: all the tools and methods also described a framework or guidelines for evaluation. The only differences might lay in the level of details provided for practical implementation of the evaluation. Such as a detailed method or roadmap; ready to use questionnaire and scoring guides etc... This level of details might allow separating the different evaluation approaches into the 4 categories described: framework (global description on how an evaluation should be performed); guideline (general roadmap to follow to implement the evaluation); method (how to implement the roadmap step by step) and tool (how and what to use to implement the evaluation). However, within the evaluation context, there is no clear definition of the specific use of these terms and the differences between them remain unclear. Moreover, there is no justification from the authors on the choice of one term rather than another. The level of detail provided by the evaluation approaches described as framework, guidelines or methods seems to be quite similar, providing general or structured roadmaps to follow for the implementation of the evaluation. Most of the identified approaches were general and provided recommendations for global evaluations. Nonetheless, several levels of evaluation are presented: evaluation of the structure and completeness of the SS, and evaluation of the quality of data provided and the performance of the SS. There is a real need for standardisation of the terminology in use in the field of SS evaluation.

4.2 Attributes selected in the evaluation approaches

Two evaluation approaches are targeting only the structure of the system: El Allaki et al (2012) and one of the WHO frameworks (2011), and do not take into consideration attributes. The method provides by El Allaki et al (2012) is a conceptual evaluation which aim at identify the missing concept in the system. Tools developed by the WHO (2011) provide a general overview on the status of prevention and control activities. Approaches targeting the performance of the system are evaluating some aspects of the structure as well. Indeed, the structure of the SS is part of the context which needs to be described in order to understand the functionality of the system, to select relevant attributes to assess according to the structure (and to evaluation objective(s)) and to provide relevant recommendations.

Within the approaches targeting the performances of the SS, only one does not use attributes for the evaluation (WHO, 2008), and two others are going through the assessment of criteria rather than attributes (Malecki et al, 2008; Dufour, 1999). Other approaches take into consideration between 6 and 22 attributes, and only SERVAL (Drewe, Hoinville et al. 2013) provides a selection process of these attributes. Some documents, such as the CDC updated guidelines (German et al, 2001), are providing a list of attributes, explaining that it is not always relevant to assess them all according to the context and the objectives of the evaluation. Nonetheless there is no guide for their selection, and this step requires a specific knowledge about surveillance. Most of the approaches provided definitions of these attributes, directly in their roadmap or in annex documents.

4.3 Advantages and limitations

4.3.1 Lack of recommendations for the implementation

Only few approaches provided recommendations regarding the type of evaluator needed to implement an evaluation, and regarding the level of expertise and skills required. Moreover, there is no information related to the time, resources, data and materials required.

4.3.2 Lack of detailed methods and tools for attributes' assessment

Only one approach (described as a tool) provided clear methods or tools for the assessment of attributes. However the tool lacked flexibility and transparency in the choice of attributes and assessment process. In most cases, guidance is provided by giving examples of questions to ask to key stakeholders. These questions are mostly general, and it is not always specified who should be interviewed to collect relevant information. In other cases, references to publications implementing methods or tools for the assessment were provided and could be used as examples or basis for the assessment.

4.3.3 Lack of economical and sociological aspects

When looking at the type of attributes considered in the evaluation approaches, mostly structural and performances attributes are included (Annex).This review highlights the lack of economic attributes or criteria taken into consideration in the evaluation approaches. Some suggest assessing the cost, or cost-effectiveness, but only SERVAL (Drewe et al, 2013) provides references to guide the implementation of economic assessment. Indeed, in the actual context, these criteria could have an important role for SS, especially regarding decision-makers. As described in the paper by Auer and co-workers (2011), acceptability can be considered as an underpinning attribute, which reflects the importance of taking into consideration stakeholders involved in the SS.

4.3.4 The issue of « gold standards »

None of the approaches provided gold standards to guide the interpretation of the results of an evaluation, and which should help to provide relevant recommendations for system improvement. Economic standards also need to be considered in the evaluation approach, as it is necessary to understand what are the financial constraints at stake are in the decision making process of SS improvement.

4.4 Ways of improvement

4.4.1 Needs for a complete, flexible and operational guide

According to these results, some recommendations could be provided for the development of an improved evaluation approach. Indeed based on the existing approaches, there is a need to develop a complete, flexible and operational guide to help evaluators implement evaluation of SS.

The integrated approach should provide a full list of attributes which could be used for the evaluation, giving their definition and the methods and tools existing for the assessment. It should be flexible and adapted to the context and evaluations constraints (time, resources, available data, etc.). The ideal guide should be operational and provide the evaluators selection choice of methods and tools to be implemented in the field and best adapted to their context.

4.4.2 Needs for guidance on methods and tools

For the assessment of the selected attributes several methods exist, either quantitative or qualitative. The selection of the fitted method, or tool, is not easy and a guide should be provided to help evaluators to make their choice. It would be necessary to identify the advantages and limits of the methods and tools, as well as the requirements (i.e. data required, technological requirement, methodological competence, etc.). This guide will allow another level of flexibility in the evaluation. Processes to implement these methods and tools should also be described, detailing each step of the process.

4.4.3 Importance of economic and sociological aspects

Economic and social aspects should be part of the evaluation approaches at two levels. Indeed, Economic aspect are central issue in most decision making process and allow for better selection and/or ranking of corrective measures to be implemented. Sociological aspects need to be considered to ensure the SS sustainability and impact. Attributes linked to social aspects will inform on the correct process of the SS and will provide relevant information on stakeholders' perception and expectation required for its improvement. Attributes targeting these elements should be developed and should be part of the evaluation approach, along with adapted methods and tools for their assessment.

These elements should also be taken into consideration within the evaluation approach. Indeed, the implementation of an evaluation can be costly, and it is necessary to define to which level of details the results are expected to be with the associated cost estimated accordingly. Similarly, acceptability relates to the adequacy and relevance of an evaluation and evaluation methods in relation to the needs and interests of the system's stakeholders (Auer, Dobmeier et al. 2011).

5 Conclusion

Several organizations have developed their own frameworks and guidelines for the evaluation of SS, each providing different level of details for implementation and targeting only partial aspect of the SS characteristics. This review highlights the needs to develop an integrated approach based on the existing ones, providing practical methods and tools for its implementation and not only covering the epidemiological aspects for the evaluation but also the social and economic aspects. This review was performed under the framework of RISKSUR project, which aims at developing this type of integrative decision support tools for the design of cost-effective surveillance systems. The project will provide decision makers with tools that allow the design of more cost-effective animal health surveillance and thereby reduce direct and indirect impact of animal diseases on European citizens.

6 References

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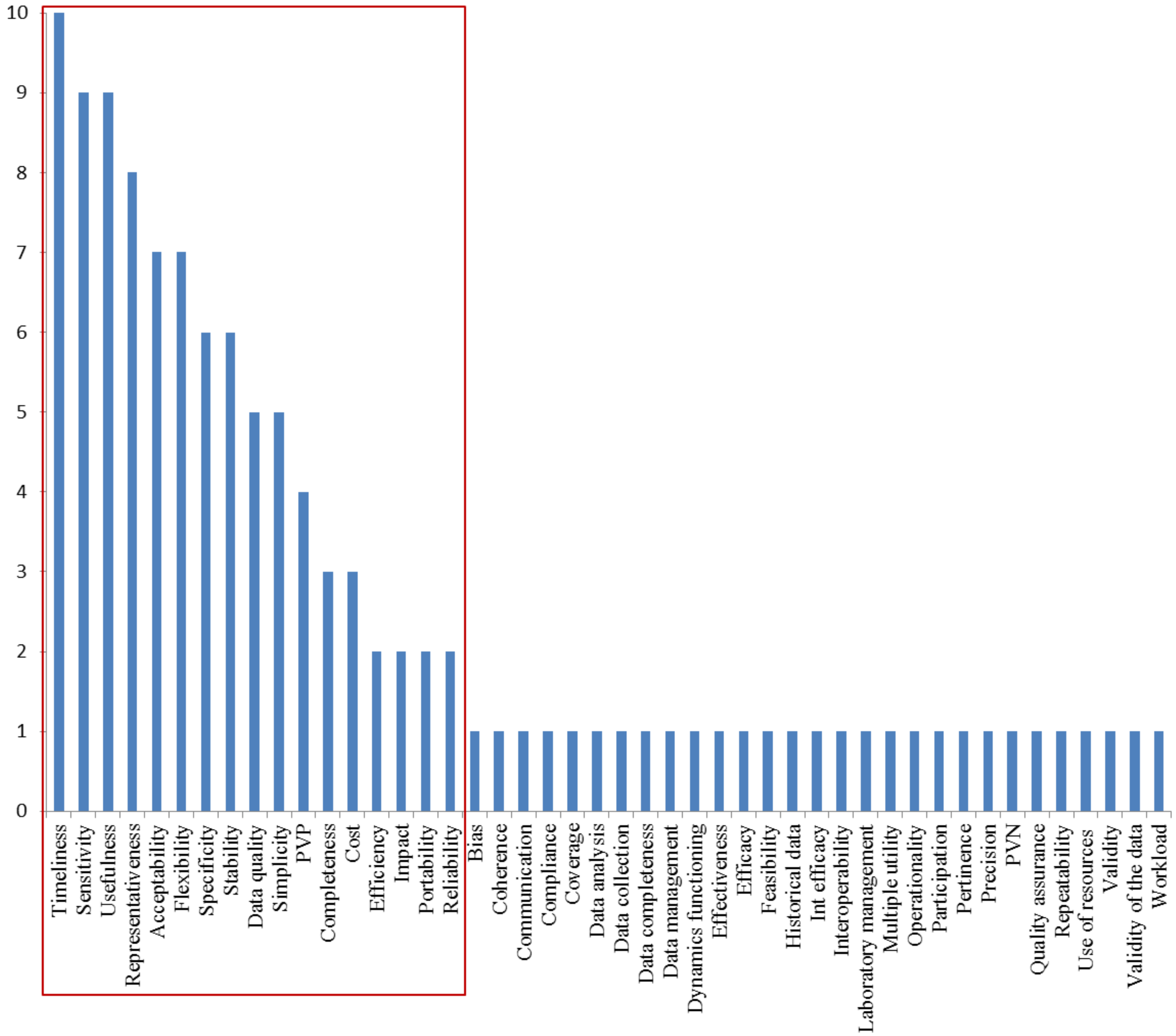
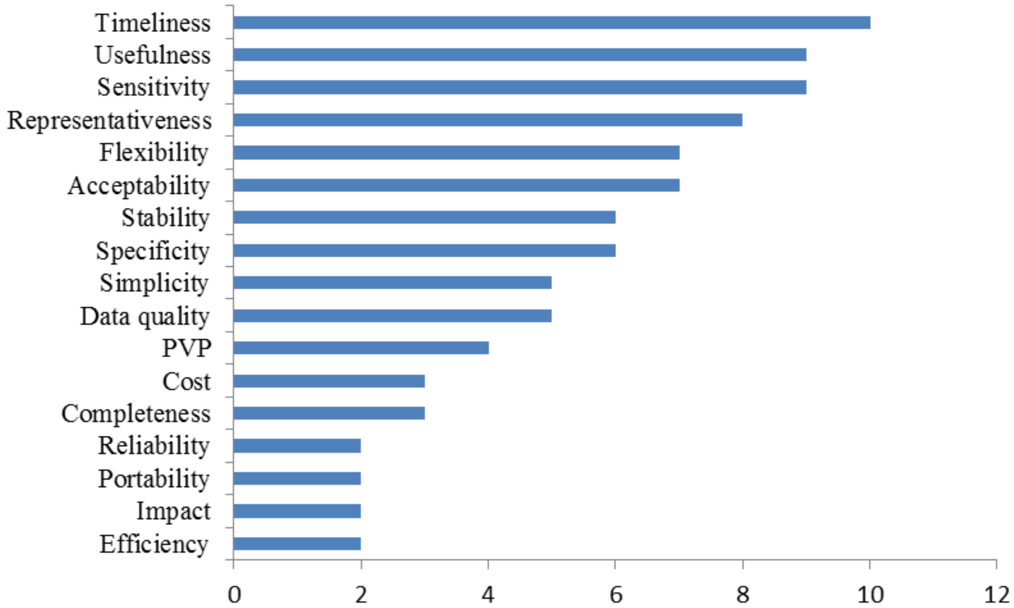
7 Appendix

List of attributes included in the evaluation of surveillance systems approaches identified through the systematic review and number of times they were included.





Timeliness
Usefulness
Sensitivity
Representativeness
Flexibility
Acceptability
Stability
Specificity
Simplicity
Data quality
PVP
Cost
Completeness
Reliability
Portability
Impact
Efficiency
0
2
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