

## General Interest

# Looking Inside the International Food Safety Authorities Network Community Website

CARMEN JOSEPH SAVELLI<sup>1,2\*</sup> AND CÉU MATEUS<sup>2</sup>

<sup>1</sup>World Health Organization, Nutrition and Food Safety, Avenue Appia 20, 1211, Geneva, Switzerland (ORCID: <https://orcid.org/0000-0001-5929-7249> [C.J.S.]); and <sup>2</sup>Lancaster University, Faculty of Health and Medicine, Division of Health Research, Bailrigg, Lancaster LA1 4YW, UK (ORCID: <https://orcid.org/0000-0001-6219-219X> [C.M.]

MS 20-193: Received 15 May 2020/Accepted 16 June 2020/Published Online 18 June 2020

## ABSTRACT

The International Food Safety Authorities Network (INFOSAN) was launched in 2004 by the World Health Organization (WHO) in collaboration with the Food and Agriculture Organization of the United Nations (FAO). Since then, this global network has aimed to halt the international spread of contaminated food, prevent foodborne disease outbreaks, and strengthen food safety systems globally to reduce the burden of foodborne illness. However, INFOSAN has never been examined as a functional community of practice and its value, according to members, has not been determined in a systematic or rigorous way. A three-phased, mixed-method study has explored the experiences of INFOSAN members with respect to their participation in collaborative network activities to improve global food safety and prevent foodborne illness. Results from phase 1 of this study are discussed here and relate to how the INFOSAN Community Website (ICW) is being used to support network activities. Overall, the descriptive analysis indicates that a small number of active INFOSAN members contribute most of information shared on the ICW. A much larger group of members participates passively, logging on to the site, reading content, but not sharing new information. Four hundred eighty-two food safety incidents are documented on the ICW, the majority of which have been caused by bacterial contamination, most commonly *Salmonella enterica*. The results from phase 1 of this study provide objective, foundational information about engagement of all members and were used to propose new ways to improve the ICW. Integration of these results with results from phases 2 and 3 will help determine whether and how members' reported attitudes and experiences reflect their online behaviors. This information can be used by the INFOSAN Secretariat to increase active participation and improve international information exchange to mitigate the impact of food safety emergencies and prevent foodborne diseases globally.

## HIGHLIGHTS

- Members have registered on the INFOSAN Community Website (ICW) from 182 countries.
- Most members are passive consumers of information shared by the Secretariat.
- International food safety incidents (482) are detailed on the ICW.
- Fifty-one percent of food safety incidents on the ICW involve only five pathogens.
- Suggested improvements to the ICW could support increased participation of members.

**Key words:** Community of practice; Food and Agriculture Organization of the United Nations; Food safety; International collaboration; International Food Safety Authorities Network; World Health Organization

The International Food Safety Authorities Network (INFOSAN) is a global network that aims to halt the international spread of contaminated food, prevent foodborne disease outbreaks, and strengthen food safety systems globally to reduce the burden of foodborne illness. Established in 2004, INFOSAN has since grown to include more than 600 people from 190 countries in 2020 and is jointly managed by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO), with most operational functions led

by the Secretariat at WHO. INFOSAN members are officially designated to represent national authorities that have responsibilities in managing food safety activities. The network includes members from various government sectors, including health, agriculture, veterinary services, trade, standards, and education. One of the most important functions of the network is to promote the rapid exchange of information during international food safety-related incidents, including multicountry outbreaks of foodborne illness linked to a common food and international recalls of food due to an identified human health risk (13).

For several years, most communication between the Secretariat and members of the network occurred through

\* Author for correspondence. Tel: +41 22 79 13234; E-mail: [savellic@who.int](mailto:savellic@who.int).

e-mail by using a simple software application to distribute messages to subscribers on an electronic mailing list. In 2007, an online, password-protected, collaborative platform called the INFOSAN Secure Website was launched and used mainly as a repository for alert notifications about food safety incidents with international implications (7). During the first global meeting of INFOSAN members in 2010, members indicated their desire for an improved online environment to foster a stronger sense of community among globally dispersed members and to better enable information exchange (8). Subsequently in 2012, the online platform was rebuilt and relaunched with a new name, the INFOSAN Community Website (ICW), in recognition of the network as a community of practice (9). A community of practice is a group of people sharing a particular concern, problem, or passion for an area and who deepen their knowledge and expertise by learning from one another and interacting on a regular basis (29). Since 2012, the ICW has been a vital communication tool that has not only aided the rapid information exchange during international food safety emergencies but also enabled the sharing of other important food safety-related information of global interest (e.g., guidance, publications) and the promotion of partnerships and collaboration between countries and between networks. In addition to providing the contact details of all global members, the ICW serves as a secure space to engage in conversations by using the online discussion forum (12).

Over the past 15 years, INFOSAN has marked many notable achievements, most of which are documented in biannual activity reports published by FAO and WHO (7, 9, 10–12). These include large-scale responses to serious international food safety emergencies, delivery of training and capacity building workshops, and facilitation of emergency preparedness simulation exercises, to name a few. However, the same reports have also highlighted that a lack of active participation among members creates delays in information sharing during food safety emergencies that could translate into delayed implementation of risk management measures and thus more cases of foodborne illness that could have otherwise been prevented.

A review of INFOSAN published by Savelli et al. (24) concluded that the network would benefit from further exploration into the experiences of members with respect to their participation in network activities. In doing so, barriers to active participation could be identified and addressed by the INFOSAN Secretariat. The research concluded that this could be achieved in part by examining the ICW to characterize membership and understand members' access, use, and contributions.

This article presents the results of the descriptive analysis of the ICW, representing the first phase of a three-phase research study of INFOSAN that has the overall aim of exploring and describing the experiences of INFOSAN members with respect to their participation in network activities to improve global food safety and prevent foodborne illness. The second phase of this research involves the collection of information from INFOSAN members by using an online survey and the third phase involves interviews with a small group of INFOSAN

members (between 6 and 12). The research protocol for the full study, including details on all three phases, has been published by Savelli and Mateus (25).

The main research question addressed by this first research phase is as follows: How is the ICW being used to support the network activities? Specific questions addressed include the following. (i) What are the characteristics of INFOSAN members? (ii) How are INFOSAN members using the ICW? (iii) What kind of information about international food safety events is available to members on the ICW? Results from this phase of research can be used to prioritize potential areas of improvement of the ICW that could support an increase in the active participation of members.

## MATERIALS AND METHODS

**Recruitment and consent.** In January 2019, all national INFOSAN members who were registered on the ICW (525) received an informational e-mail explaining the three different phases of the study of INFOSAN and reminding INFOSAN members that data analyzed in phase 1 of the study would be extracted from the ICW in accordance with the terms and conditions of use that each member consented to when he or she registered online. The informational e-mail and a subsequent online seminar ensured that INFOSAN members understood that anyone not agreeing to have their website access and use data used for this study had 2 weeks to make this indication by e-mail to the researcher. After this time, opting out was no longer possible due to the aggregation and anonymization of the data. Only one member expressed a desire to be excluded. As such, with 524 INFOSAN members included, nearly the entire network was recruited for phase 1 of the study.

**Data collection and analysis.** Access to the ICW was granted to the researcher as a staff member at WHO, and approval for use in this research was granted by the director of the Department of Food Safety and Zoonoses, WHO (renamed the Department of Nutrition and Food Safety in January 2020). ICW data concerning INFOSAN members and their contributions were collected retrospectively between February 2012 (when the website was launched) and December 2018. Information from all recruited members concerning the following variables was downloaded in January 2019 from the website, anonymized, and exported into Microsoft Excel for analysis: type of member (i.e., Emergency Contact Point or Focal Point), sex, languages spoken, country (aggregated to regional level), government sector, primary function (i.e., risk assessment, risk communication, or risk management), and areas of scientific expertise. These data have all been automatically collected and stored in the internal ICW database at the time of each member's registration. Additional data about length of membership, last access to the website, and discussion thread initiations, responses, and views were also exported for analysis. Once collected, all anonymized data were analyzed using descriptive summary statistics, allowing for stratification by variables including type of member and geographical region and evaluation of member activity level. For the purpose of this study, active membership is conceptualized as regularly logging on to the ICW and sharing content in the discussion forum. Information regarding international food safety incidents was also extracted for analysis, including details on hazards and food categories.



FIGURE 1. *INFOSAN* members registered on the *INFOSAN* Community Website, January 2013 to January 2019, including all members (ALL, blue lines), Focal Points (FP, gray lines), and Emergency Contact Points (ECP, orange lines).

**RESULTS**

**Types of *INFOSAN* members.** Among *INFOSAN* members (524), 186 are Emergency Contact Points from 168 countries and 338 are Focal Points from 144 countries. Emergency Contact Points are members who have been designated from a national authority with the responsibility for coordination of food safety emergency response activities. Focal Points are members who have been designated from other national authorities with a stake in food safety activities. Since the ICW was launched, the number of registered members has increased annually (Fig. 1). Among the Focal Points, 15 members are registered from eight different regional authorities (Table 1) and 5 members are registered from five different WHO Collaborating Centers (CCs; Table 2). WHO CCs are entities such as research institutes, divisions of universities, or academies that are designated by the WHO Director-General to carry

out activities in support of WHO programs. Five hundred seven members reported sex, of which 266 (52%) are male and 241 (48%) are female. Information about languages spoken was provided by 431 of 524 *INFOSAN* members at the time of registration on the ICW. Three hundred forty-eight (81%) members reportedly speak English, 88 (20%) speak Spanish, and 86 (20%) speak French. Only 10 (2%) do not report speaking English, French, or Spanish. Of those 10 members, 6 of them report speaking only Russian and 4 of them report speaking only Portuguese. Eighty-one (19%) members report speaking 1 of more than 50 different languages.

**Geographical representation.** *INFOSAN* members have been designated from nearly all WHO Member States (182 [93%] of 194; Table 3). However, the Americas is the only region in which all Member States have registered

TABLE 1. *Regional authorities with one or more Focal Point(s) registered on the ICW, January 2019*

Regional authority	Acronym	Geographic region covered	Main area of collaboration with the <i>INFOSAN</i> Secretariat
European Centre for Disease Prevention and Control	ECDC	Europe	Contributing to rapid risk and outbreak assessments during foodborne disease outbreaks in Europe
European Commission	EC	Europe	Exchanging information during food safety incidents with the Rapid Alert System for Food and Feed (RASFF)
European Food Safety Authority	EFSA	Europe	Exchanging information on emerging food safety risks through the EFSA Emerging Risks Exchange Network (EREN)
African Union Interafrican Bureau for Animal Resources	AU-IBAR	Africa	Supporting an Africa-wide rapid alert system based on <i>INFOSAN</i>
Inter-American Institute for Cooperation on Agriculture	IICA	Africa	Collaborating on training initiatives for <i>INFOSAN</i> members in the Caribbean
Arab Industrial Development and Mining Organization	AIDMO	North Africa and the Eastern Mediterranean	Engaging with the Arab Food Safety Initiative for Trade Facilitation (SAFE) project to support links with the Arab RASFF
Arab Organization for Agricultural Development	AOAD	North Africa and the Eastern Mediterranean	Engaging with the Arab SAFE project to support links with the Arab RASFF
The International Regional Organization for Plant and Animal Health	OIRSA	Central America	Collaborating on training initiatives for <i>INFOSAN</i> members in Central America

TABLE 2. WHO Collaborating Centers with Focal Points registered on the INFOSAN Community Website, January 2019

WHO Collaborating Center	Country	Topic of collaboration
Institute of Nutrition, Mahidol University	Thailand	Nutrition and food safety
National Food Institute, University of Denmark	Denmark	Antimicrobial resistance and foodborne pathogens and genomics
Singapore Food Agency	Singapore	Food contamination monitoring
Food and Environmental Hygiene Department	Hong Kong SAR (China)	Risk analysis of chemicals in food
National Institute for Public Health and the Environment	The Netherlands	Risk assessment of pathogens in food and water
Institut Pasteur	France	<i>Listeria</i> and listeriosis

INFOSAN members on the ICW. The Americas is also the only region where Member States have registered, on average, four INFOSAN members each (including one Emergency Contact Point and three additional Focal Points from different national agencies). Member States from Africa, Asia, and the Eastern Mediterranean regions have registered an average of three members each, and Member States from Europe and the Pacific have registered an average of two members each.

**Government sector represented by members.** The government sector most commonly represented by INFOSAN members is food safety (337 [64%]), followed by public health (199 [38%]), agriculture (83 [16%]), animal health (76 [15%]), trade and commerce (35 [7%]), and other sectors (30 [6%]) including, for example, consumer affairs, education, and environment.

**Primary function of members.** Upon registration, INFOSAN members were asked to indicate their primary function as either risk management, risk communication, or risk assessment. INFOSAN members most commonly report risk management as their primary function (302 [58%]), followed by risk communication (264 [50%]) and risk assessment (232 [44%]). One hundred thirty-eight (26%) members report other primary functions including, for example, surveillance, research, and standard setting.

**Scientific expertise of members.** INFOSAN members report a wide range of scientific expertise, including (in descending order) food safety (365 [70%]), public health (237 [45%]), foodborne disease surveillance (151 [29%]), food science and technology (142 [27%]), microbiology (139 [27%]), outbreak investigation (134 [26%]), epidemiology (116 [22%]), emergency management (106 [20%]), animal health (88 [17%]), chemistry (68 [13%]), toxicology (51 [10%]), biotechnology (33 [6%]), and other (33 [6%]) including, for example, nutrition, plant protection, management, and administration.

**Length of membership.** The average INFOSAN member has been registered on the ICW for 3 years 10 months. For Emergency Contact Points, the average is 4 years 5 months, and for Focal Points, the average is 3 years 6 months. INFOSAN members registered on the INFOSAN Community Website in 2012 represent the largest group (136 [26%]).

**Access to the ICW.** As of January 2019, the majority of INFOSAN members had logged on to the ICW within the preceding 6 months (270 [52%]). However, 194 (37%) members had not accessed the ICW in more than a year, including 70 (13%) members who had not accessed the site in three or more years (Table 4). Across regions, the majority of members from the Americas (92 [63%]), Asia (39 [61%]), and the Eastern Mediterranean (38 [73%])

TABLE 3. Geographical representation of INFOSAN members registered on the INFOSAN Community Website by region, January 2019

Region <sup>a</sup>	Registered members (n)	Member States represented (n)	Total no. of Member States per region (n)	Avg no. of members per Member State (n)	Regional Member State coverage (%)
Africa	120	43	47	3	91
Americas	147	35	35	4	100
Asia	64	21	22	3	95
Eastern Mediterranean	52	18	21	3	86
Europe	112	50	53	2	94
Pacific	29	15	16	2	94
Global	524	182	194	3	93

<sup>a</sup> Regional divisions of Member States in Africa, the Americas, the Eastern Mediterranean, and Europe are based on coverage provided by the WHO regional offices. Asia includes the Member States from the WHO South-East Asia region plus 11 Asian countries from the WHO Western Pacific region: Brunei Darussalam, Cambodia, China, Japan, Lao People's Democratic Republic, Malaysia, Mongolia, Philippines, Republic of Korea, Singapore, and Viet Nam. The Pacific group includes the remaining Pacific island countries from the WHO Western Pacific region. These regional divisions were recommended by the INFOSAN Advisory Group because of differences in the ways that INFOSAN activities have been historically organized and current practices in regional food safety management.

TABLE 4. Last access to the INFOSAN Community Website by INFOSAN members, stratified by type of member (Emergency Contact Point or Focal Point), January 2019

Last access	All members, n (%)	Emergency Contact Points, n (%)	Focal Points, n (%)
<1 mo	77 (15)	40 (22)	37 (11)
1–3 mo	64 (12)	24 (13)	40 (12)
3–6 mo	129 (25)	39 (21)	90 (27)
6–12 mo	60 (11)	26 (14)	34 (10)
1–2 yr	96 (18)	27 (15)	69 (20)
2–3 yr	28 (5)	8 (4)	20 (6)
3+ yr	70 (13)	22 (12)	48 (14)
Total	524 (100)	186 (100)	338 (100)

accessed the ICW during the preceding 6 months, whereas the majority of members from Africa (75 [63%]), Europe (63 [56%]), and the Pacific (22 [76%]) did not access the website during the preceding 6 months (Table 5).

**Use of the discussion forum.** The INFOSAN discussion forum provides an environment for asynchronous conversations to occur among members and the INFOSAN Secretariat. These discussions are visible to all registered INFOSAN members, and any member can read and respond to the threads. For summary purposes, the discussion threads have been assigned to one of four topic categories based on the most accruing themes: (i) food safety incidents, (ii) training, (iii) announcements, and (iv) feedback.

From 2012 to 2018, a total of 136 discussion threads were initiated in the forum. This excludes discussions held within subgroups on the website that are private and only visible to select group members. Sixty-seven member-initiated threads were made by members from 26 different countries; however, two-thirds of these threads (45 [67%]) were started by just 10 members from 10 different countries. Members from the Pacific were responsible for initiating the most threads (18 [27%]), followed by members from Asia (17 [25%]), the Eastern Mediterranean (12 [18%]), Africa (8 [12%]), the Americas (8 [12%]), and Europe (4 [6%]).

Overall, 578 replies have been made across the 136 discussion threads. Sixty-six (11%) of those replies came from the Secretariat or someone else at FAO or WHO. The remaining 512 (89%) replies were made by 177 members

from 116 countries. Twenty members from 19 countries were responsible 216 replies (42%). Members from the Americas were responsible for the most replies (186 [36%]), followed by members from Africa (109 [21%]), Asia (85 [17%]), the Eastern Mediterranean (62 [12%]), the Pacific (40 [8%]), and Europe (30 [6%]).

Fifty-seven (42%) of 136 of the discussion threads consist of only a single post (i.e., no one replied to the original message). Among these threads with no replies, they were viewed an average of 53 times (maximum, 228; minimum, 8). Overall, the minimum number of views of any thread is 8 and the maximum is 879. On average, each discussion includes three replies (Table 6).

Discussions about food safety incidents represent nearly half of all topics (61 [45%]) and typically include responses from INFOSAN members detailing national risk management measures implemented in response to a specific food safety incident. Discussions about training opportunities represent about a quarter of all topics (33 [24%]). Many of these posts include details about upcoming opportunities offered by the INFOSAN Secretariat or members' institutions or otherwise refer members to Web-based training resources (e.g., recorded technical webinars on various food safety topics). Announcements about upcoming events (e.g., World Health Day, publication of new food safety guidance or resources) account for 27 (20%) of the discussion topics. Requests for feedback (e.g., comments on draft documents, ideas for future publications) are the topics of 15 (11%) of the discussion threads.

**Number of food safety incidents on the ICW.** The ICW contains information about 482 food safety incidents dating back to 2005. Events dating from 2005 to 2011 were added retrospectively when the ICW was launched in 2012 (Table 7).

The majority of incidents have been caused by contamination with bacteria (268 [56%]) followed by chemicals (81 [17%]), physical hazards (42 [9%]), viruses (35 [7%]), undeclared allergens (22 [5%]), unknown hazards (17 [4%]), parasites (8 [2%]), other hazards (7 [1%]), or fungi (2 [0.4%]; Table 8).

Ten hazards most frequently responsible for food safety incidents account for 59% of all those documented on the ICW. Nearly a quarter of these involve *Salmonella enterica* (110 [23%]) followed by *Listeria monocytogenes* (49 [10%]), enterohemorrhagic *Escherichia coli* (38 [8%]),

TABLE 5. Last access to the INFOSAN Community Website by INFOSAN members, stratified by geographic region, January 2019

Last access	All members, n (%)	Africa, n (%)	Americas, n (%)	Asia, n (%)	Eastern Mediterranean, n (%)	Europe, n (%)	Pacific, n (%)
<1 mo	77 (15)	14 (12)	25 (17)	11 (17)	10 (19)	13 (12)	4 (14)
1–3 mo	64 (12)	8 (7)	22 (15)	9 (14)	10 (19)	14 (13)	1 (3)
3–6 mo	129 (25)	23 (19)	45 (31)	19 (30)	18 (35)	22 (20)	2 (7)
6–12 mo	60 (11)	13 (11)	15 (10)	0 (0)	8 (15)	17 (15)	7 (24)
1–2 yr	96 (18)	30 (25)	26 (18)	10 (16)	5 (10)	18 (16)	7 (24)
2–3 yr	28 (5)	13 (11)	6 (4)	4 (6)	0 (0)	4 (4)	1 (3)
3+ yr	70 (13)	19 (16)	8 (5)	11 (17)	1 (2)	24 (21)	7 (24)
Total	524 (100)	120 (100)	147 (100)	64 (100)	52 (100)	112 (100)	29 (100)

TABLE 6. *INFOSAN Community Website discussion forum activity, 2012 to 2018*

	2012	2013	2014	2015	2016	2017	2018	Overall
Registered members	215	250	311	372	439	506	524	524
Discussion forum threads	14	17	8	14	15	35	33	136
Secretariat-initiated threads	3	4	3	3	9	28	19	69
Member-initiated threads	11	13	5	11	6	7	14	67
Avg no. of views per thread	80	64	172	144	134	111	116	113
Minimum no. of views per thread	12	9	18	21	10	8	17	8
Maximum no. of views per thread	189	292	597	740	313	879	660	879
Avg no. of replies per thread	2	2	6	6	4	3	3	3
Minimum no. of replies per thread	0	0	0	0	0	0	0	0
Maximum no. of replies per thread	6	9	21	21	20	34	20	34
Mode replies per thread	0	0	4	0	0	0	0	0

*Clostridium botulinum* (35 [7%]), hepatitis A virus (16 [3%]), norovirus (13 [3%]), peanut (allergen; 9 [2%]), methanol (adulterant; 6 [1%]), *Vibrio* spp. (6 [1%]), and *Cronobacter sakazaki* (6 [1%]; Table 9).

Foods from 10 categories most frequently responsible for food safety incidents account for 78% of all those documented on the ICW. Fish and other seafood top the list (63 [13%]), followed by milk and dairy products (57 [12%]); meat and meat products (54 [11%]); vegetables and vegetable products (42 [9%]); fruit and fruit products (41 [9%]); herbs, spices, and condiments (37 [8%]); snacks, desserts, and other foods (34 [7%]); nuts and oilseeds (27 [6%]); products for special nutritional use (21 [4%]); and cereals and cereal-based products (17 [4%]; Table 10).

## DISCUSSION

The ICW is more than just a website. It is an international knowledge exchange portal meant to assist in knowledge management for evidence-informed decision-making on issues related to food safety. Based on the results of this analysis, the INFOSAN Secretariat has made it a strategic objective to redesign and relaunch the ICW as a

TABLE 7. *Number of food safety events documented on the INFOSAN Community Website, 2005 to 2019*

Year	No. of food safety incidents
2005	2
2006	3
2007	8
2008	12
2009	5
2010	2
2011	46
2012	42
2013	44
2014	39
2015	37
2016	37
2017	43
2018	78
2019	84
Total	482

modern tool to facilitate improved collaboration among members (13). By updating the ICW, the INFOSAN Secretariat can contribute to a stronger community of INFOSAN members, who are more connected and capable of leveraging the worldwide knowledge and expertise available to combat global food safety emergencies.

Information about membership including user access to the ICW indicates a rather mature membership with good retention. However, there are a relatively small number of very active members (i.e., those members who regularly log on to the ICW and share content in the discussion forum). In the literature, these very active members are sometimes referred to as “super-users” or “community champions” because they are members who regularly share information, engage in discussions, and encourage others to do the same (16). A substantial proportion of members are completely disengaged from network activities that are administered through the ICW. In addition, the data suggest that the majority of INFOSAN members visiting the ICW only ever read content and do not actively contribute new knowledge. Inspiring community members to participate actively has been identified as a key to success in previous studies of online communities (18, 19). This result is not unexpected according to a review by Sun et al. (27), who explain that the silent groups in online communities, known as “lurkers,” commonly comprise the largest group of community members. Possible reasons for such behavior identified by Sun et al. (27) include environmental

TABLE 8. *Frequency of hazards involved in food safety incidents (482) documented on the INFOSAN Community Website, 2005 to 2019*

Hazard category	No. (%) of food safety incidents
Bacteria	268 (56)
Chemicals	81 (17)
Physical hazards	42 (9)
Viruses	35 (7)
Undeclared allergens	22 (5)
Unknown	17 (4)
Parasites	8 (2)
Other	7 (1)
Fungi	2 (0.4)
Total	482 (100)

TABLE 9. Top 10 specific hazards involved in food safety incidents documented on the INFOSAN Community Website, 2005 to 2019

Specific hazard	No. (%) of food safety incidents
1. <i>Salmonella enterica</i>	110 (23)
2. <i>Listeria monocytogenes</i>	49 (10)
3. Enterohemorrhagic <i>Escherichia coli</i>	38 (8)
4. <i>Clostridium botulinum</i>	35 (7)
5. Hepatitis A virus	16 (3)
6. Norovirus	13 (3)
7. Peanut (allergen)	9 (2)
8. Methanol (adulterant)	6 (1)
9. <i>Vibrio</i> spp.	6 (1)
10. <i>Cronobacter sakazaki</i>	6 (1)
Top 10	282 (59)

influences, personal preferences, individual–group relationships, and security or privacy considerations. Several strategies for motivating participation in online communities are also provided by Sun et al. (27), including the provision of external stimuli, improvement of user friendliness of the online community interface, encouragement of participation from an administrator or fellow members, and guidance for new community members.

With observations of member access and use in mind, the ICW should be relaunched as a modern knowledge exchange portal that encourages increased engagement of INFOSAN members and a higher volume of active participants contributing to the ICW on a regular basis.

A new ICW could facilitate knowledge management through three core activities: knowledge access, knowledge creation, and knowledge transfer and exchange. This can be achieved first by providing a single integrated point of access to a variety of relevant food safety emergency information for INFOSAN members worldwide; second, by creating and maintaining knowledge directories about member-generated content including details about food safety events and emergencies; and third, by facilitating information sharing and distribution and providing collaborative features that help to foster the community of practice among INFOSAN members. A recent systematic review of empirical studies by Malinen (21) aimed at better understanding user participation in online communities concluded that universal design recommendations for online communities have been difficult to create given the heterogeneity of different communities and the speed at which technology changes, including the ways in which people interact with technology. Community platforms such as the ICW should therefore be fit for purpose to best support the members in achieving the objectives of the network. Based on the results of this study and current best practices reported in the literature, we have determined a total of 14 specific functions (1 to 14) and five characteristics (15 to 19) for inclusion in a new ICW as described below and depicted in Figure 2.

**Food safety incident pages (1).** The new ICW should provide time-sensitive information about international food

TABLE 10. Top 10 foods involved in food safety incidents documented on the INFOSAN Community Website, 2005 to 2019

Food category	No. (%) of food safety incidents
1. Fish and other seafood	63 (13)
2. Milk and dairy products	57 (12)
3. Meat and meat products	54 (11)
4. Vegetables and vegetable products	42 (9)
5. Fruit and fruit products	41 (9)
6. Herbs, spices, and condiments	37 (8)
7. Snacks, desserts, and other foods	34 (7)
8. Nuts and oilseeds	27 (6)
9. Products for special nutritional use	21 (4)
10. Cereals and cereal-based products	17 (4)
Top 10	376 (78)

safety incidents to members worldwide. All incident pages should include a standard set of information that can be selected from drop-down lists to search and filter for incidents. Members should be able to interact with food safety incident pages by adding comments and uploading documents that would refer to response actions taken in their own country because of an incident. This kind of activity accounts for the greatest proportion of member contributions on the current ICW and should continue to be encouraged and supported. The information on food safety incident pages would benefit members by notifying them of potential international food safety issues and facilitating the implementation of preparedness and risk management measures. Nearly a quarter of the incidents recorded on the ICW involve food contamination with nontyphoidal *S. enterica*. According to estimates published by the WHO in 2015, *S. enterica* is also the foodborne hazard that presents the greatest disease burden in terms of disability adjusted life years at the global level. Mitigating the impact of this pathogen should continue to be a priority for INFOSAN members (30). Reading what others have done in response to instances of food contamination with *S. enterica*, or any other foodborne hazard, can aid INFOSAN members in their own national response efforts to prevent illness (14).

**Member details (2).** The new ICW should contain the contact details of all members (this information should be automatically populated from an online registration form). The Secretariat frequently needs to contact members and request or provide information about ongoing food safety incidents, and members may need to contact each other on a bilateral basis to inquire about food safety issues. Members will need to export member details based on predefined criteria (e.g., all members from one region). Automatically generated “country profile” pages should also be available from each user’s personal dashboard upon login, providing an overview of membership and recent involvement in food safety incidents. The Secretariat should be able to edit all members’ details, and members should be able to edit their own details. Having such details available to all members aids in preparedness and facilitates urgent communication during food safety incidents (6). For example, the ability to

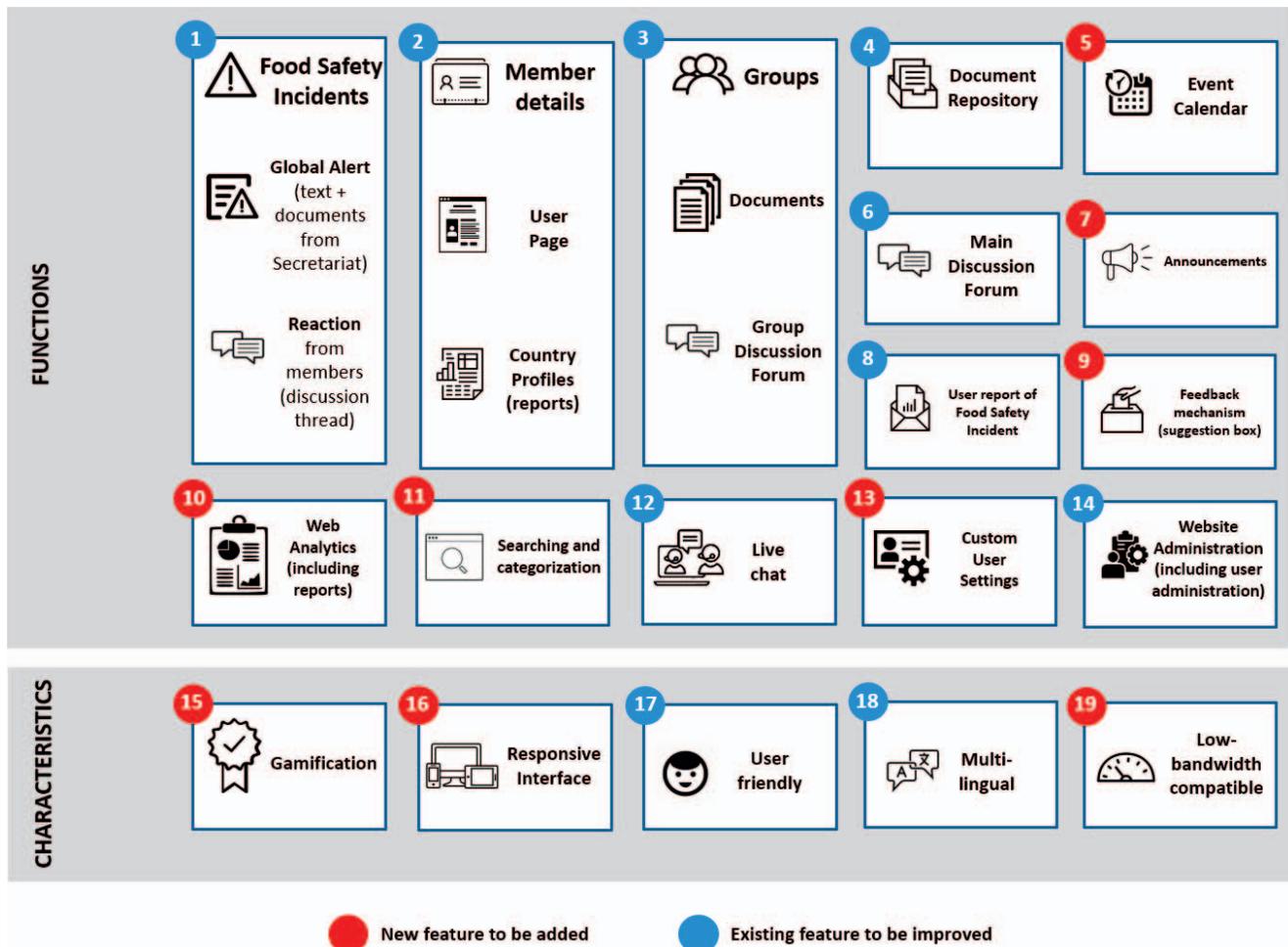


FIGURE 2. Fourteen specific functions and five characteristics proposed for inclusion in a redesigned INFOSAN Community Website, including new features to be added (red circles) and existing features to be improved (blue circles).

export contact information can help when creating contact lists for specific incident responses or meetings. Country profiles illustrate involvement in past food safety incidents and can help to quickly review national membership, making it easier to assess if updates need to be made.

**Groups (3).** The option to create subgroups within the ICW should be an option for members themselves, either open to all, or with membership to be agreed by the manager of the group. Such groups could be, for example, groups of members that share a common language or belong to the same region, or they could be based on specific food safety topics. Members of groups should be able to upload documents and hold discussions in these groups (and the content within groups would only be visible to the members of the group). Members could benefit from participating in groups by exchanging information on specific topics of interest, exchanging experiences and resources, and learning new things (16).

**Document repository (4).** The document repository would provide an organized place to store documents. All documents that are uploaded to the ICW would be indexed into the document repository, making it easy for users to

find what they are looking for (e.g., training materials). Both the Secretariat and members should be able to upload documents that are indexed into the repository, but ownership should be clear (e.g., Secretariat document versus member document). Having a document repository that is easily searchable will make it easier to find content on the new ICW and is a helpful tool to aid in knowledge creation and dissemination (22, 28).

**Event calendar (5).** An event calendar would allow the Secretariat or members to add details about important upcoming events (e.g., regional INFOSAN meetings) and populate them with details and attachments. Both the Secretariat and members should be able to create events, but there should be a clear delineation between member-created events and Secretariat-created events. Members would benefit by having a clear indication of upcoming events of potential interest and would be encouraged to attend.

**Main discussion forum (6).** The discussion forum will allow users to communicate asynchronously on food safety topics of concern (including ongoing incidents) and should integrate standard features of modern discussion forums. Any user can initiate a new thread in the forum; discussions

may be moderated by the Secretariat; users should be able to add attachments to their text including a range of media types (e.g., documents, videos). The forum benefits members by fostering a learning community and facilitation interaction between members and the Secretariat. The forum allows for the sharing of new knowledge and the exchanging of ideas to improve food safety. In previous studies of online communities of practice, participation in discussion forums has been linked to several positive outcomes as it can indicate loyalty and satisfaction (1).

**Announcements (7).** The Secretariat should be able to make announcements to all members (e.g., pop-up notification when a member logs on to the ICW). Announcements may be linked to calendar events and would benefit members by alerting them to important information of potential interest (e.g., new report published, new event planned). This kind of function can contribute to knowledge dissemination.

**User-generated report of a food safety incident (8).** INFOSAN members should be able to access a template on the ICW to report a food safety incident to the Secretariat. This would function as a downloadable template that could be e-mailed to WHO (using a members' e-mail client). Having a template for reporting food safety incidents encourages the provision of more complete information during a response effort (14).

**Feedback mechanism (i.e., virtual suggestion box) (9).** The INFOSAN Secretariat strives for continuous improvements and welcomes feedback from members. Members should be able to leave feedback (anonymously) with suggestions on how to improve the ICW or INFOSAN operations in general. Obtaining feedback in this way opens a direct line of communication and demonstrates the willingness of the Secretariat to take on board members' suggestions to drive improvement. Several studies of online communities have demonstrated that high member satisfaction is associated with an increased sense of belonging, less turnover, and increased participation (2, 5, 23).

**Web analytics (including reports) (10).** The INFOSAN Secretariat needs to be able to understand how the website is being used over time, both to track the benefits and identify and solve issues. Automated monthly reports should be generated and e-mailed to the Secretariat to quantify (i) traffic, (ii) new content (e.g., new reports, incidents, documents), (iii) new members, (iv) liveliness (e.g., new posts, number of members posting), (v) interaction (e.g., number of "likes" of posts, number of replies to posts), and (vi) responsiveness (e.g., speed of posts when new content is uploaded, speed of replies to posts). There should be a dashboard that displays these different metrics that includes customizable options to allow for exported reports with all or some of the information (e.g., by time, or country, or region, or members). Adding built-in Web-analytic functionality will aid the INFOSAN Secretariat in understanding better how members are using

the site and identify certain areas that may need improvement to boost collaborative knowledge sharing on the ICW. Monitoring the activity of members in this way can help to identify "champions" who can help to inspire others to increase their activity (16).

**Searching and categorization (11).** It is important that users and the Secretariat can simply and effectively find useful information on the website. This will include identification of past and current events and alerts, searches for different members, information topics, and documents and items in forums or groups. As part of this, consideration needs to be given to any categories or directory structures used as well as the search functionality included. All users should be able to search all content, and this will benefit members by enabling them to find the information they seek quickly and enhance the exchange of knowledge and information. This can especially be vital during global food safety events where the rapid exchange of information is essential.

**Live chat (12).** Users need to be able to identify who is currently online and be able to interactively chat with other users or the Secretariat who are currently online. Any users who are logged on to the ICW should be able to start a chat with any other members who are online. This will support user participation and will allow the Secretariat to maintain a closer relationship with users. This could also help to initiate spontaneous dialog and boost knowledge exchange between members that would not otherwise have the chance to converse.

**Custom user settings (13).** A settings dashboard should allow users to change their settings regarding e-mail notifications they receive from the ICW (e.g., every time a new discussion thread is started, or a weekly digest). Users should be able to subscribe or unsubscribe to various content on the ICW (recognizing that a core set of information would always be transmitted to members when it concerned a food safety incident requiring immediate action). Being able to customize what information is sent by e-mail to members can eliminate e-mail fatigue and ensure that members are getting the information they are interested in, in their desired format and frequency.

**Website administration, including user administration (14).** As resources are limited, a flexible and intuitive design is needed for the Secretariat to administer the website (13). User-friendly Web administration will save time for the INFOSAN Secretariat and ensure the website is kept up to date for a better user experience.

**Gamification (15).** Gamification may involve the automatic or manual assignment of virtual badges or awards for certain types of member engagement (e.g., using the discussion forum, sharing documents, reporting incidents to the Secretariat, reporting milestones in length of membership). Such badges would be displayed on a member's profile. The Secretariat should be able to predefine badges

or awards that are automatically bestowed as well as customize badges or awards that may be presented ad hoc. Recent studies have shown that gamifying learning environments and online collaboration spaces can boost learning performance (3) as well increase both the quality and quantity of knowledge contributions (26). Members may appreciate acknowledgement for contributions and gamification may contribute to increased participation and contribution on the ICW.

**Responsive interface (16).** Relying on current best practices, all pages should have an adaptive behavior, taking care of both screen resolutions and touch devices. A responsive interface could encourage improved participation by members as many have indicated they more often use mobile devices to access the ICW. As was discussed at the Global Meeting of INFOSAN members in December 2019, more than 80% of members agreed that a mobile-friendly version of the ICW would improve participation (15).

**User friendly (17).** The interface of the new ICW should be optimized for mobile devices, focus on primary tasks of the site, elevate the most relevant content, and give users a logical path to follow for easy navigation to provide a good user experience. The new ICW user interface should focus on several key principles, including clarity, user centricity, simplicity, consistency, and a strong visual hierarchy (20). A more user-friendly site should encourage increased use of the ICW by users.

**Multilingual (18).** The website interfaces need to be multilingual to support the international community which uses it. Because 98% of INFOSAN members speak either English, Spanish, or French, this has important implications for the language of program delivery, including for the design of the interface of the new ICW and for the information shared with members and food safety alerts posted on the ICW. Users should be able to select in which language the user interface is displayed; there should be an option to autotranslate the other content on the site using an external internet translation tool. Multilingualism enables a greater proportion of the global membership to consume content on the ICW and the translated interfaces facilitate greater participation.

**Low-bandwidth compatible (19).** With membership spanning the globe, many users are in places where the Internet is very slow. The website needs to be able to adapt to that reality. Users should have the ability to switch between high- and low-bandwidth versions of the new ICW. Such compatibility will ensure all users worldwide will have equal opportunities to access the information shared and make contributions to the ICW in accordance with their local situation. Collaborations that are more inclusive of all participants are more likely to share complex forms of knowledge and be more motivated overall (17).

**Study limitations.** One limitation of this study is that the data represent access to and use of the ICW at a single point in time and have not allowed for trend analysis over any period. Related to this, active participation in the context of this study has been conceptualized as logging on to the ICW and sharing content in the discussion forum. However, there are other possible ways to use the ICW that may provide value to members that have not been captured by this analysis. For example, members may log on to the website to find the contact details of other members and then engage in a conversation by e-mail or phone, or by using the chat function. Establishing these connections is also a form of participation but has not been captured by the current analysis.

In conclusion, the descriptive analysis of the ICW has helped to illuminate how it is being used to support INFOSAN activities. It has provided a characterization of a diverse group of members and detailed their access and use of the website, which is mainly limited to a relatively small group of active members. The analysis has also provided an overview of information about international food safety incidents that are summarized on the website, providing insight to the most commonly implicated foods and hazards. These results will provide information to the INFOSAN Secretariat to inform decisions to redesign and relaunch the ICW to improve member engagement and knowledge management. Results from this study have already been used to inform the development of a request for proposals from potential vendors to build the new website that has been disseminated through the United Nations Global Marketplace (31).

While characterizing the network in this way is informative, additional research is required to understand the barriers and enablers to active participation and the value that participating in INFOSAN has to participants, including whether members believe that participation improves global food safety and prevents foodborne illness. These aspects will be addressed in phases 2 and 3 of the ongoing study of INFOSAN.

Results from phases 2 and 3, triangulated with results from phase 1, will help determine whether members' reported attitudes and experiences reflect their online behaviors. In addition, triangulated data will allow for INFOSAN to be described with respect to its stage of community development according to Wenger et al. (29) considering its structuring characteristics as described by Dube et al. (4).

By better understanding members' experiences, INFOSAN can be further improved, facilitating more rapid communication on matters of food safety, preventing foodborne illness and saving lives globally.

## ACKNOWLEDGMENTS

C. J. Savelli conceived the original idea, designed the study, drafted the article, and approved the final document. C. Mateus drafted the article and approved the final document. C. J. Savelli is a staff member of the WHO. We alone are responsible for the views expressed in this publication and do not necessarily represent the views, decisions, or policies of the WHO. We thank Professor Alan Reilly, Dr. Jorgen Schludnt, and Dr. Robert Verburg for technical input to the study protocol that has guided

this research. We also thank staff from the FAO, WHO INFOSAN Secretariat for review of an earlier draft of this article, including Dr. Ceyhun Gungor, Dr. Raul Garcia, Dr. Peter Ben Embarek, and Dr. Kosuke Shiraiishi.

## REFERENCES

- Blanchard, A., and M. Markus. 2004. The experienced “sense” of a virtual community. *ACM SIGMIS Database* 35:64.
- Cullen, R., and S. Morse. 2011. Who’s contributing: do personality traits influence the level and type of participation in online communities. *Hawaii Int. Conf. Syst. Sci.* 11:1–11.
- Davis, D., G. Chen, C. Hauff, and G. Houben. 2018. Activating learning at scale: a review of innovations in online learning strategies. *Comput. Educ.* 125:327–344.
- Dube, L., A. Bourhis, and R. Jacob. 2006. Towards a typology of virtual communities of practice. *Interdiscip. J. Inf. Knowl. Manag.* 1:69–93.
- Escobar, M., P. Kommers, and A. Beldad. 2014. Using narratives as tools for channeling participation in online communities. *Comput. Human Behav.* 37:64–72.
- Food and Agriculture Organization of the United Nations, World Health Organization. 2010. FAO/WHO framework for developing national food safety emergency response plans. Available at: <http://www.fao.org/3/i1686e/i1686e00.pdf>. Accessed 30 April 2020.
- Food and Agriculture Organization of the United Nations, World Health Organization. 2011. INFOSAN progress report: 2004–2010. Available at: [https://www.who.int/foodsafety/publications/infosan\\_progress\\_report/en/](https://www.who.int/foodsafety/publications/infosan_progress_report/en/). Accessed 30 April 2020.
- Food and Agriculture Organization of the United Nations, World Health Organization. 2011. First global meeting of INFOSAN: meeting report. Available at: [https://www.who.int/foodsafety/publications/infosan\\_global\\_meeting/en/](https://www.who.int/foodsafety/publications/infosan_global_meeting/en/). Accessed 30 April 2020.
- Food and Agriculture Organization of the United Nations, World Health Organization. 2013. INFOSAN activity report 2011–2012. Available at: <https://www.who.int/foodsafety/publications/activity-report-2012/en/>. Accessed 30 April 2020.
- Food and Agriculture Organization of the United Nations, World Health Organization. 2014. INFOSAN activity report 2013. Available at: <https://www.who.int/foodsafety/publications/activity-report-2013/en/>. Accessed 30 April 2020.
- Food and Agriculture Organization of the United Nations, World Health Organization. 2016. INFOSAN activity report 2014–2015. Available at: [https://www.who.int/foodsafety/publications/infosan\\_activity2014-15/en/](https://www.who.int/foodsafety/publications/infosan_activity2014-15/en/). Accessed 30 April 2020.
- Food and Agriculture Organization of the United Nations, World Health Organization. 2018. INFOSAN activity report 2016–2017. Available at: [https://www.who.int/foodsafety/publications/infosan\\_activity2016-17/en/](https://www.who.int/foodsafety/publications/infosan_activity2016-17/en/). Accessed 30 April 2020.
- Food and Agriculture Organization of the United Nations, World Health Organization. 2019. INFOSAN secretariat strategic plan, 2020–2025. Available at: <https://apps.who.int/iris/handle/10665/329913>. Accessed 30 April 2020.
- Food and Agriculture Organization of the United Nations, World Health Organization. 2020. INFOSAN members’ guide 2020. Available at: <https://www.who.int/activities/responding-to-food-safety-emergencies-infosan>. Accessed 30 April 2020.
- Food and Agriculture Organization of the United Nations, World Health Organization. 2020. Second global meeting of INFOSAN: meeting report. Available at: <https://www.who.int/publications/item/9789240003934>. Accessed 12 June 2020.
- Ford, J., H. Korjonen, A. Keswani, and E. Hughes. 2015. Virtual communities of practice: can they support the prevention agenda in public health? *Online J. Public Health Inform.* 7:e222.
- Gungor, C. 2019. Collaborative learning and knowledge sharing in food sustainability. Ph.D. dissertation. University of London, UK. Available at: <https://openaccess.city.ac.uk/id/eprint/23673/>. Accessed 12 June 2020.
- Koh, J., and Y. Kim. 2004. Knowledge sharing in virtual communities: an e-business perspective. *Expert Syst. Appl.* 26:155–166.
- Koh, J., Y. Kim, B. Butler, and G. Bock. 2007. Encouraging participation in virtual communities. *Commun. ACM* 50:68–73.
- Lee, M. K., C. M. Cheung, K. H. Lim, and C. L. Sia. 2006. Understanding customer knowledge sharing in web-based discussion boards. *Internet Res.* 16:289–303.
- Malinen, S. 2015. Understanding user participation in online communities: a systematic literature review of empirical studies. *Comput. Human Behav.* 46:228–238.
- Nonaka, I. 2006. Organizational knowledge creation theory: evolutionary paths and future advances. *Organ. Stud.* 27:1179–1208.
- Park, J. H., B. Gu, A. C. M. Leung, and P. Konana. 2014. An investigation of information sharing and seeking behaviors in online investment communities. *Comput. Human Behav.* 31:1–12.
- Savelli, C., A. Bradshaw, P. Ben Embarek, and C. Mateus. 2019. The FAO/WHO International Food Safety Authorities Network in review, 2004–2018: learning from the past and looking to the future. *Foodborne Pathog. Dis.* 16:480–488.
- Savelli, C., and C. Mateus. 2019. A mixed-method exploration into the experience of members of the FAO/WHO International Food Safety Authorities Network (INFOSAN): study protocol. *BMJ Open* 9:e027091.
- Suh, A., and C. Wagner. 2017. How gamification of an enterprise collaboration system increases knowledge contribution: an affordance approach. *J. Knowl. Manag.* 21:416–431.
- Sun, N., P. Rau., and L. Ma. 2014. Understanding lurkers in online communities: a literature review. *Comput. Human Behav.* 38:110–117.
- Venkatraman, S., and R. Venkatraman. 2018. Communities of practice approach for knowledge management systems. *Systems* 6:36.
- Wenger, E., R. McDermott., and W. Snyder. 2002. *Cultivating communities of practice*. Harvard Business School Press, Cambridge, MA.
- World Health Organization. 2015. WHO estimates of the global burden of foodborne diseases. Available at: <https://www.who.int/publications/item/9789241565165>. Accessed 12 June 2020.
- World Health Organization. 2019. Development of the INFOSAN community website v2.0. Available at: <https://www.ungm.org/Public/Notice/99166>. Accessed 30 April 2020.