Deliverable 2.1 Mappings of existing framework conditions, challenges, system failures and gap analysis

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MAIN AUTHOR(S)	Christina Golna (HPI), Chara Tzavara (HPI), Ioannis-Anestis Markakis (HPI), Pavlos Golnas (HPI), Aikaterini Ntokou (HPI), Kyriakos Souliotis (HPI)

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ABBREVIATIONS

ABBREVIATION	Full Name
CDC	Centers for Disease Control and Prevention
ECDC	European Center for Disease Prevention and Control
GI	Gastrointestinal Infections
ICS	Integrated Care Systems
IHR	International Health Regulations
IMO	International Maritime Organization
NFP	National Focal Points
PCR	Polymerase Chain Reaction
PLF	Passenger Locator Form
PPE	Personal Protective Equipment
SLR	Systematic Literature Review
UNCLOS	United Nations Convention on the Law of the Sea
WHO	World Health Organization
WSP	Water Safety Plan

Publishable Summary

This Deliverable 2.1 aims to define the current framework of managing the most prevalent communicable health hazards on board a cruise ship, including contemporary recommendations, guidelines, and state-of-the-art technological solutions, in every pillar of the public health continuum (prevention, screening and early detection and risk containment/mitigation) and during all phases of travel (before embarkation, during travel, upon disembarkation), to identify where gaps currently may lie, what solutions may be available to address these gaps and how willing would passengers and crew be to accept and implement or follow those solutions.

Section 1 discusses findings from a Systematic Literature Review (SLR). The SLR confirmed that, despite screening and early identification being cardinal in prompt diagnosis and effective risk mitigation, there seems to be limited reference in the literature and policies to specific tools and methods to perform large scale screening for the most common communicable diseases amongst passengers and crew of cruise ships. To validate this starting point and address this practice gap, an internal Consortium workshop was held with the participation of cruise and technological partners. The workshop, presented in Section 2 validated the gap analysis, worked on several scenarios, and ranked proposed technological solutions. Outputs from the workshop informed the development of the stated preference surveys' questionnaires which were conducted amongst passengers and crew of cruise ships (Section 3). The surveys were designed to assess the preferences for and willingness of passengers and crew to endorse and implement technical state of the art solutions proposed by HS4U for the screening for and early detection of communicable diseases on board cruise ships and to correlate willingness and concerns with passengers' and crew's sociodemographic and baseline health status characteristics. Results from these surveys revealed a wide disparity amongst passengers and crew with regards to acceptance of possible technological solutions for the early detection of communicable diseases on board cruise ships. Though the crew appears more well prepared to accept and endorse use of such technologies, partly to ensure greater health safety in its place of work, passengers are more hesitant to sign up for such solutions, in their overwhelming majority because of monitoring and / or data security concerns. This is particularly true for wearables (e.g., smartwatches) for health monitoring. Finally, a second Workshop with our External Advisors (Section 4) validated the Deliverable 2.1 methodology and the outputs of Sections 1 to 3 above.

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1. Introduction

In principle, international travel can rapidly and extensively affect global health[1]. An array of epidemic prone diseases such as the pandemic (H1N1) in 2009 which originated in Mexico[2], the Middle East Respiratory Syndrome Corona Virus, which was isolated in 2012 in Saudi Arabia[3], the Chikungunya virus which emerged in the Americas in Saint Maarten in December 2013[4, 5] and the Ebola Virus in West Africa in March 2014[6], were introduced into non-endemic areas through travel. Most of these communicable diseases occurring during international travelling by ship, can be acquired through contaminated food and water, already infected individuals embarking on the ship, as well as environment[7-9]. Several challenges, such as already infected individuals, development of a virus due to poor cleaning and safety measures, seasonal infections, and others, are introduced while cruising, often leading to transmission of health hazards that are seen on ships or also on land[8, 10].

Such challenges are further exacerbated on board cruise ships. These are very large vessels, which transport thousands of passengers and crew on a single trip, with a typical cruise ship carrying 2,000 passengers and 800 crew, and larger ships having a capacity of more than 5,000 passengers and 2,000 crew[2]. Outbreaks of infectious diseases on board cruise ships are natural consequences of travelling in such crowded and closed or semi-closed settings. The impact is further compounded by the fact that the average cruise lasts longer than 6 days, there are frequent group activities that increase passenger and crew contact and facilitate the spread of infection, and frequent stops are made, when passengers can leave the ship and new passengers and crew can board, providing new reservoirs for infection[11].

Marshall et al. [12] combined reports from Barbados Port Health Department from 2009 to 2013 and estimated that communicable diseases appear in 15.7 cases per 100,000 passengers, with the most common being food - and waterborne infections, respiratory infections, and other miscellaneous infections. The most recent infection to cause a global pandemic, Coronavirus 19 (COVID-19), is also extensively reported as a major public health hazard on board cruise ships[13] and has negatively affected the cruise industry, due to widespread disruptions and cancellations affecting millions of cruise passengers[14]. Moreover, it impacted on future willingness to cruise and attitudes towards cruising for both cruisers and non-cruisers[14]. More specifically, within the first 4 months of the pandemic outbreak, i.e., until April 2020, nearly 30 cruise ship voyages had reported COVID-19 cases[15, 16]. The Diamond Princess, Grand Princess and Ruby Princess cruise ship had reported over 1,400 COVID-19 cases, and more than 30 deaths[15]. Influenza[17-19] and gastroenteritis[20-22] also consistently reported in the literature as major communicable health hazards on board a cruise ship. Legionnaire’s disease is equally highlighted as an infectious disease with a grave public health and economic impact on board cruise ships[23-27].

The continuing high impact of infectious diseases on board cruise ships, highlighted during the COVID-19 pandemic, has demonstrated the urgency to re-assess existing regulations and protocols[28] on maritime health and safety branches as well as optimize the current naval architectural and marine engineering systems to prevent, mitigate and manage such health emergencies.

Unfortunately, several gaps in current regulations and available guidelines and resources on preventing, mitigating, and managing such outbreaks, seem to exist, particularly with regards to roles and responsibilities and the cooperation mechanisms of different actors in relation to public health emergencies during travel[15, 16]. It is suggested that travel-related international regulations, including the International Health Regulation (IHR) [29], United Nations Convention on the Law of the Sea (UNCLOS), the World Health Organization's recommendations and the International Maritime Organization (IMO) conventions should be further updated to deal with travel health problems[16].

Within this remit, the HS4U project aspires to bridge cross-sectoral stakeholder expertise to offer a new value chain connecting user requirements, system's technical specifications and the performance of pilot demonstrations, and involving user groups – ship operators, citizens, first responders, crisis managers, resource/infrastructure managers, and public agencies. In adopting a holistic approach, it presents a multidisciplinary, multidomain offering that expands and cross-fertilizes research findings within 4U(nique) pillars offerings best practices, lessons learnt, regulation frameworks and suggestions for protocol optimization.

Deliverable 2.1. (D.2.1., part of Work Package 2) entitled "Mapping of existing framework conditions, challenges, system failures and gap analysis" defines current challenges in ship prevention, mitigation and management of health hazards and puts forward specific requirements for the HS4U-proposed solution in naval architecture. These requirements are defined based on the meta-analysis of multiple sources and validated through a workshop with internal partners, including cruise partners. Additionally, the consortium sought insights from crew and passengers of cruise ships to define operational and strategic challenges of existing prevention, mitigation and management of health hazards regulations and protocols and assess patient and crew preferences as well as willingness to comply to additional or different rules and processes, as proposed by the Consortium.

This Deliverable 2.1 is structured in a modular manner and includes the following sections:

Section 1. Systematic Literature Review of guidelines, recommendations, and state-of-the-art solutions for managing the most communicable health hazards on board cruise ships.

Section 2. Internal workshop (with consortium partners) to validate the findings of the SLR and agree on next steps, including the conduct of a stated preference survey amongst passengers and crew of cruise ships.

Section 3. Stated preference surveys amongst passengers and crew of cruise ships.

Section 4. External workshop (with members of the External Advisory Board) to review the methodology and the outputs of this Deliverable 2.1.

2. Section 1. Systematic Literature Review

2.1 Introduction – Aim of this review.

This section summarizes the findings of a systematic literature review (SLR) conducted to address the following research questions and set the scene for the definition of any gaps or requirements in addressing most prevalent and impactful health hazards on board cruise ships:

1) What is the prevalence or frequency of the most common communicable health hazards on cruise ships?
2) What are the commonly used indicators to report on these communicable diseases on board cruise ships?
3) What is the burden or impact of these prevalent communicable diseases on cruise ships?
4) Are there available guidelines to prevent or manage outbreaks of these communicable diseases on board cruise ships?

2.2 Methodological Approach

This review follows the core principles of a systematic literature review according to the PRISMA statement[30]. These include the description of the search strategy, with information sources, the definition and reporting of inclusion criteria and processes, the formulation of concepts, search algorithm and key words and data extraction procedures using the PRISMA flow chart steps, and a results' tables, as reported herein below.

2.2.1 Search strategy and inclusion process

We conducted an extensive search in multiple bibliographic databases, namely MedLine - Pubmed, Scopus, the Cochrane Library and Google scholar. In addition to these searches, a hand-search of the reference lists of eligible papers was used to increase accuracy and provide the final number of eligible studies. More specifically, hand research focused on research questions 3 and 4 by searching a wide range of official organizations' websites, such as the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), the European Center for Disease Prevention and Control (ECDC), and the European Commission. Lastly, other documents that are not based on a research study and may report observations or common knowledge we considered grey literature and were screened but not always included in the qualitative analysis. We included such references only when other sources were lacking. Furthermore, specific inclusion and exclusion criteria were defined to guide and frame the search (Table 1).

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Table 1: Inclusion and exclusion criteria of the SLR

Inclusion criteria	Exclusion criteria
Studies from 2015 to-date (8 years)	Studies prior to 2015
Observational studies and randomized trials, reviews, systematic reviews, and meta-analyses	Purely laboratory work-experiments (not tested in the field)
Human objects	Animals
English or Greek	Other languages
Available full text	Not available full text

Our search approach included defining several core keywords that were used to form the main search algorithm and screen resulting articles. These were the following: **cruise ship, health threat, disease, communicable disease, outbreak, prevalence, epidemiology, indicator, index, measure, management, mitigation, mitigation plan, emergency treatment, treatment**.

The final form of the main algorithm used in the official data sources was: **(health threat or communicable disease or disease or epidemic or outbreak) and (cruise ship or cruise or cruise ship or ship or on dock) and (prevalence or frequency or indicator or index or measure or rate).**

2.2.2 Screening and data extraction

We searched each database and filtered for the inclusion-exclusion criteria, to export several potentially relevant articles. These articles were carefully screened based on the PRISMA criteria[30], as follows. First, we screened them by title, then by abstract and then by full text (Figure 1). The final number of relevant articles to be assessed for inclusion and used in the analysis was extracted in a dedicated excel sheet.

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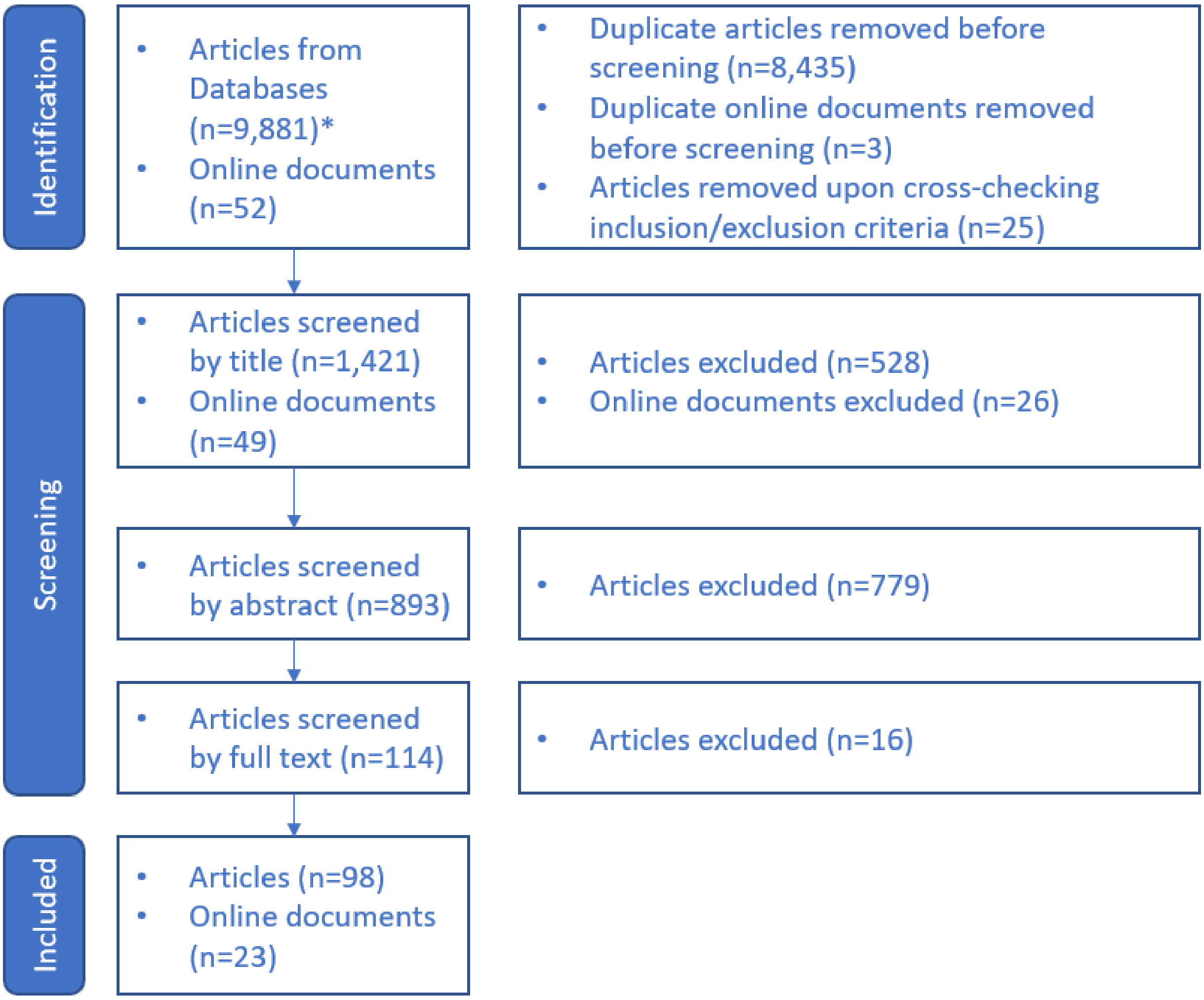

* Articles break down: 1352 Pubmed, 138 Scopus, 91 Cochrane Library, 8300 Google Scholar

Figure 1: PRISMA flowchart for identification and screening of studies via databases, websites, and other sources

This data extraction sheet was developed, piloted, and refined, following data extraction guidelines[31, 32]. We extracted data on study identifiers and characteristics, including article title, first author name, journal and year of publication, study type/design and doi number. Additionally, hyperlinks of the article's online publication as well as pdf. files. Tables 14 and 15 in the Appendix summarize this information.

2.2.3 Data assessment

We assessed data based on specific next steps and methods. We used thematic analysis and horizontal screening to identify, extract and present relevant information. Different sets of tables were developed to present data derived from included articles, as described in detail herein below.

2.3 Results

A total of 95 articles and 23 online documents are utilized in the analysis. Most of the studies are published in 2020 and 2021, after the onset of COVID-19, with examples and surveillance reports from the pandemic. The majority are observational studies, mainly cross-sectional and cohort, while some are modeling studies and surveillance short communications/reports.

Table 2 presents an overview of communicable health hazards that the literature mentions as ever reported on cruise ships. Of these, the most frequently reported are COVID-19, influenza, gastrointestinal infections and legionellosis.

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Table 2: Communicable health hazards on cruise ships

Gastrointestinal infections	Respiratory infections	Skin infections	Infections acquired at ports of call
Noroviral infections	SARS-CoV-2 / COVID-19	Varicella	Malaria
Enterotoxigenic Escherichia coli	Influenza (A and B)	Hot tub folliculitis	Meningitis
Salmonella gastroenteritis	Rubella	Community-acquired methicillin-resistant S. aureus folliculitis	Yellow fever
Shigella species	Measles		Typhoid
Vibrio species	Legionella species		
Clostridium perfringens	Diphtheria		
Campylobacter jejuni			
Staphylococcus aureus enteritis			
Cyclospora species			
Cryptosporidium species			
Trichinella spiralis			
Hepatitis E			
Hepatitis A			

Source: Kak[33].

2.3.1 Most frequently reported serious communicable diseases/health hazards on cruise ships

Table 3 summarizes results of the SLR on the epidemiology and public health burden of the top 4 communicable health hazards reported on cruise ships.

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Table 3: Epidemiological and health burden indicators reported for SARS-CoV-2/COVID-19 on cruise ships

Communicable Health hazard	# Of studies referenced / total # of studies in the SLR	Reported epidemiological indicators*(lowest to highest reported value)*
SARS-CoV-2 / COVID-19	34/95	**Prevalence:** 2.3 -7.4%[34] 11.4%[35] 13.7% [36] (crew) 14% [37] 16.7%[38] 17%[39] 19.2%[15, 37, 40, 41] 20.4%[36] 22%[36] 23.9%[42] 25%[15] 25.1%[43] 33.4%[44] (crew) 35%[42, 45] 59%[46] **Positive test/Population tested:** 3.4%[40] (passengers) 6%[40] (crew) 16.6%[15, 47] 17%[39] 18.8%[48] 19.2% [46, 49] 20.6%[35, 38] 22%-32%[50] 23.8%[51] 23.9%[52] 25-40%[53]

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		26%[54] 35.1%[53] 46.7%[15, 47] **Asymptomatic individuals / total COVID-19 cases:** 14%[53] 14% -73%[47] 17.9%[55] 21%[54, 56] 29%[43] 42% [57] 44.8%[36] (crew) 46.1%[44] (crew) 46.5%[15, 41, 49, 58] 51%[38, 41] 51.9%[34] 57,7%[36] 58.9%[48] 74%[45] 81%[46] **Attack Rate:** 3.3%-4.8%[40] 7.2%[59] (passengers) 8.66%[60] (0.03% – 75.12%) 18%-81%[54, 56] 19.2%[58] 24%-41%[42] 20.6% - 30%[36] 25.8 – 32.5%[59] (crew) 92%[57] **Basic Reproduction number – R0:** 0.2[61] 1.78[39, 41]

		2.28[39, 62] 2.46 - 5.7[34] 3.27-4.73[41] 6.94[61] 9.3%[45] 14.8[39] 1.1 – 7.0[63] (Rt) 11.2 (crew) – 12.1 (passengers)[63] (Rt) **% Of cases on board cruise ships/total COVID-19 cases:** 14.9% - 60%[64] **% Of deaths on board cruise ships/total COVID-19 deaths:** 26.6%[64] **% Of asymptomatic cases not detected:** 53%[45] **Hospitalization rate:** 4.5%[48] 9.7%[58] (intensive care) 10-25%[49] 19.2%[50] **Proportion of deaths/Hospitalizations:** 1%[50] **Proportion of deaths / Positive tests:** 1.7%[65] **Mortality:** 1%[48] **Case Fatality Ratio:** 0.5%-8%[66] 1.05%[64]

		1.3%-2.6%[67] 1.36%[64] 1.8%[56, 58] 4.9%[64] 0.39%-12.50%[64]

Table 4: Epidemiological and health burden indicators reported for influenza on cruise ships

Communicable Health hazard	# Of studies referenced / total # of studies in the SLR	Reported epidemiological indicators *(lowest to highest reported value)*
Influenza	9/95	**Prevalence:** 2%-7%[68, 69] 2.7%[17] 3%[70] 3.0%-3.6%[18, 69] 3.1% (crew) - 3.7% (passengers) [18, 19] 4.7% (crew) - 6.2% (passengers) [18, 19] 10.9% (crew) [21] 13% (crew) [69] 32.7% (passengers) [21] **Incidence amongst children visiting ship's medical center:** 44.4%[18] **Positive test/Population tested:** 71% (75% passengers, 64% crew) [24] **Attack rate:** 0.6% (passengers) [21] 1.32% (crew) [21] **Hospitalization rate**: 49% (passengers) - 52% (crew) [18] 0.005% (daily) [49] **Mortality:** 0.96%[18] 0.005% (daily) [49]

Table 5: Epidemiological and health burden indicators reported for gastrointestinal infections on cruise ships

Communicable Health hazard	# Of studies referenced / total # of studies in the SLR	Reported epidemiological indicators *(lowest to highest reported value)*
Gastrointestinal infections (Noroviral infections and Salmonella gastroenteritis)	9/95	**Prevalence:** 0.2% (crew) [21] 3.3% - 30.3% (passengers) [71] 3.3% - 4.7% (crew) [71] 5% (crew) - 11.5 (passengers)% [72] 17% (passengers) [21] **Incidence rate:** 2.81/10,000 traveler days[20] 5.2/10,000 (crew) [22] 5.04 – 6.00/10,000 person-days[73] 16.9/10,000 (passengers) [22] 19.8/100,000 travel days (crew extra-large ships) [22] 22.3-/10,000 travel days (passengers) [74] 21.3/10,000 travel days (crew) [74] **Attack rate:** 0.6% (passengers) [21] 1.32% (crew) [21] 19.37/10,000 travelers[20] 18.2%[75] **Hospitalization rate:** 28,7%[75] **Virus propagation rate:** ≤5%[76] **Probability of outbreak-Odds Ratio (if 4/1,000 passengers reported symptoms within 2 days):**

		11%[20] **Probability of outbreak-Odds Ratio (if 5/1,000 passengers reported symptoms within 3 days):** 23%[20] **Risk Ratio (RR) for outbreak (depending on days of delay to report symptoms):** 2.35 (1 day), 5,66 (2 days), 8.66[20] *Note: Norovirus accounted for 93% of total gastrointestinal infections cases[71]*

Table 6: Epidemiological and health burden indicators reported for legionnaire's disease on cruise ships

Communicable Health hazard	# Of studies referenced / total # of studies in the SLR	Reported epidemiological indicators *(lowest to highest reported value)*
Legionnaire's disease	4/95	**Prevalence:** 2.2% (passengers)[27] **Positive /total samples tested:** 16.7% (Legionella pneumophila sg 1) - 33% (L. pneumophila sg 2–14) – samples of shower and tap water[25] **Mortality rate:** 10-25%[26] **# Of cases as a % of confirmed cases (laboratory and clinical):** 55,4%[23] **Median number of cases per event:** 4[23] **Attack rate:**

		3.7% (confirmed cases)– 6.8% (60-69 age group) [27] **Fatal cases as a % of total cases:** 7.2%[23]

Notes: Beyrer et al. [27], this paper was excluded from the SLR flowchart since it was published in 2007, but it was added in the table by hand research since there were no prevalence data published after 2015.

COVID-19 is a viral respiratory infection caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). First detected in Wuhan, China in early December 2019, the virus spread quickly resulting in a global pandemic with substantial morbidity and mortality. Common symptoms of infection include fever (>37.5˚C), cough, fatigue, and a sore throat. Asymptomatic cases account for a minority of infections but are implicated in the transmission of COVID-19. The latter is thought to spread mainly from person-to-person, between people who are in close contact with one another (within about 6 feet) through respiratory droplets produced when an infected person breathes, coughs or sneezes. It may be possible to get COVID-19 by touching a virus-contaminated surface or object, and transmission might also happen before people show symptoms.

Additionally, Plucinski et al. [54] presented an attack rate of individuals in single-person cabins of 18% in contrast to 63% and 81% in a shared cabin with an asymptomatic or symptomatic COVID-19-infected person, respectively. The authors stated that a triage by symptoms without considering the cabin status may be deficient to assess the risk for COVID-19 infection. More dramatical findings were presented by Röcklöv et al. [39] and Mizumoto and Chowell[63]. The former reported that the basic reproduction rate was found to be 4 times higher on-board ships (14.8) in comparison to the reproduction rate in Wuhan (3.7) at the early stage of the outbreak, while the latter reported a reproduction rate of 11.2 (crew) to 12.1 (passengers).

Influenza, a respiratory tract infection, is also highly common on cruise ships according to the WHO[77]. The CDC[78] notes that influenza or similar illnesses can occur at any time of the year and are not seasonal. That reflects the fact that cruise ship passengers come from countries around the world that are experiencing different seasons at any given time. The signs and symptoms of influenza can be mild to life-threatening.

Further, the WHO[77] has determined that most of the gastrointestinal disease occurrences on cruise ships are associated with the consumption of contaminated food or water. The most common virus detected to date is the norovirus, which is spread easily from one passenger to another. It is highly infectious and in an outbreak on a cruise ship, more than 80% of the passengers can be affected. Other common gastrointestinal illnesses are caused by E. coli and Salmonella.

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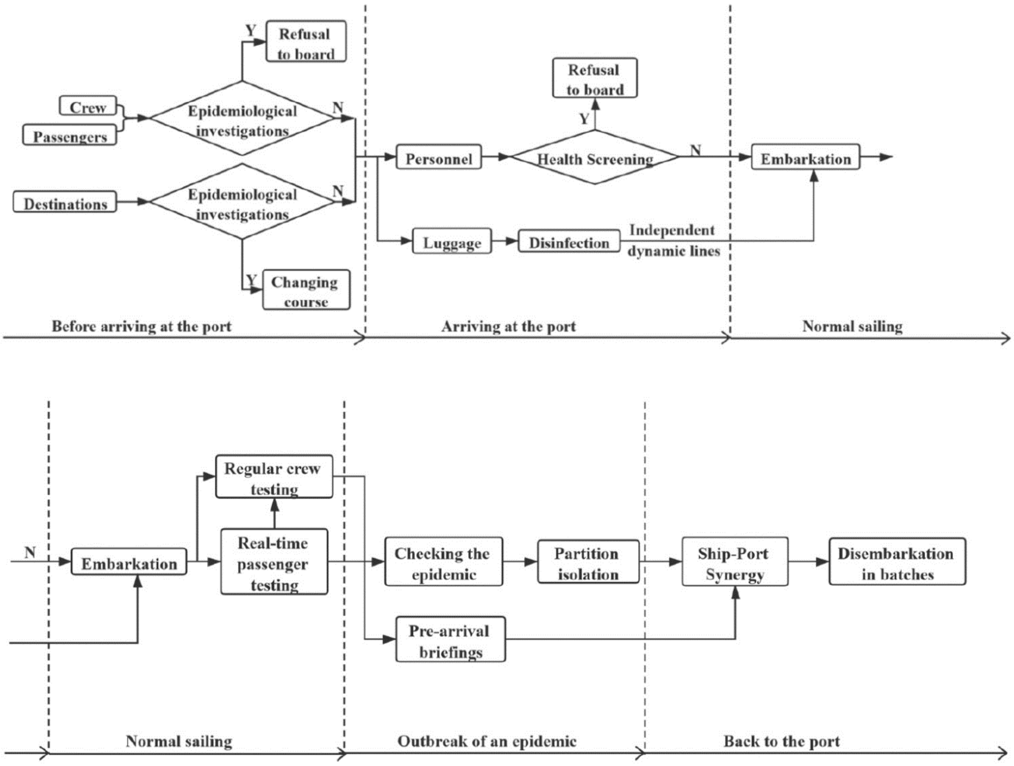
Legionellosis (legionnaires' disease) is a potentially fatal form of pneumonia, first recognized in 1976. The disease is normally contracted by inhaling Legionella bacteria deep into the lungs. Legionella species can be found in tiny droplets of water (aerosols) or in droplet nuclei (the particles left after water has evaporated). More than 50 incidents of legionellosis, involving over 200 cases, have been associated with ships during the past three decades. For example, an outbreak of legionellosis occurring on a cruise ship in 1994, resulted in 50 passengers on nine other cruises becoming infected, with one death. The disease was linked to a whirlpool spa on the ship. Other sources have been potable water supplies and exposure during port layovers[77].

Hepatitis A is another common virus transmitted through contaminated food, water, or fecal matter, as reported by WHO and CDC. However, it is not reported by the scientific literature as occurring frequently on-board cruise ships.

Additionally, varicella was reported as the most common skin infection on cruise ships according to the CDC[78]. In 2009 it even exceeded H1N1 influenza A, which was the most reported disease at the time. Varicella causes frequent outbreaks aboard cruise ships, and because varicella complications occur more frequently in adults, cruise ship outbreaks have the potential to involve serious illness since most cruise ship passengers and all crew are adults.

2.3.2 Recommendations to manage public health impact of communicable diseases on cruise ships.

Li et al. [79] note that the risk of communicable diseases on cruise ships can be summarized in the following three key components: a) the risk of viruses when boarding the ship; b) the risk of virus transmission on board the ship; c) the method to control the spread of the disease after contracting the virus. A systematic and comprehensive disease risk management framework for cruise ships is recommended, taking into consideration the uniqueness of each cruise ship (e.g., journey and disease timeline, demographic profile of passengers, high risk population groups on board, etc.), so that a reasonable cruise ship disease risk management process can be achieved. This is illustrated in Figure 2.



Source: Li et al. [79].

Figure 2: Cruise ship disease risk management process

Furthermore, there is a range of manuals, guidebooks and other documents that present necessary actions or standards for managing or controlling for communicable disease outbreaks on cruise ships, issued either by competent international public health bodies or agreed, as a result of dedicated European Union projects and initiatives.

The following Tables (7 - 10) present available recommendations and guidelines regarding public health management measures for the four (i.e., COVID-19, influenza, gastrointestinal infections, legionnaire's disease) most common disease outbreaks on cruise ships. Recommendations are grouped according to where they fall in the public health management continuum, from prevention, to screening and diagnosis through to risk mitigation / containment. Tables 11 - 13 consolidate guidelines and recommendations per communicable disease (COVID-19, influenza, and gastrointestinal infections) and public health pillar (prevention, screening and diagnosis and risk mitigation/containment). All recommendations under each public health pillar in all Tables are grouped by chronological order in one of three phases of a cruise travel, namely (a) before or upon embarkation, (b) on board the ship and (c) prior to or upon disembarkation.

In addition to the documents presented in Tables 7 - 13 below, the WHO[29] Handbook (2016, refers to International Health Regulations 2005) assists competent authorities at the local level to manage potentially internationally significant public health events at ports. This document[29] addresses events which have the likelihood of adversely affecting the health of the human population, may spread internationally, or may present a serious and direct danger to health. It follows an all-hazard approach, but addresses events related to biological hazards in more detail than those related to chemical and radiological hazards. This technical advice intends to assist competent authorities at ports to conduct risk assessment in the context of International Health Regulations (IHR), to respond in a consistent manner to events and to make decisions on interventions that are commensurate to the risks, while avoiding unnecessary interference with international traffic and trade. This document targets personnel who are responsible for event management at ports, such as personnel working in public health, medical, veterinary, environmental, customs, port state control and occupational health services. This advice can be also useful to IHR National Focal Points (NFPs) and shipping companies, ship masters, officers, and crew. WHO has also issued the "Handbook for Inspection of Ships and Issuance of Ship Sanitation Certificates" [80], which provides guidance for preparing and performing ship inspection, completing the certificates, and applying public health measures within the framework of International Health Regulations.

As the Handbook (2016, 2011) [29, 80] provides a generalized context that applies across communicable diseases and other health hazards, it is referenced here and excluded from Tables 7 - 13.

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Table 7: Recommendations and guidelines for public health management measures for **COVID-19**

Guidelines/recommendations	Prevention	Screening and diagnosis	Risk containment	Other
By: ICS-International Chamber of Shipping (ICS) **Title:** *Coronavirus (COVID-19) – Guidance for Ship Operators for the Protection of the Health of Seafarers, Fifth Edition (2022)* [81]	**Before/ Upon embarkation** • Complete locator card before embarkation • Implement procedures to reduce risk of bringing COVID-19 onboard the ship (screening questionnaires, temperature scanning or measurement, quarantine, and testing) • Deny embarkation to those experiencing signs and symptoms of COVID-19 **On board the ship** • Enforce hand hygiene and cough etiquette • Wear masks (medical) • Maintain physical distancing • Avoid all non-essential contact or proximity with other seafarers and any other persons • Use external stairways/escape routes and walkways to move around the ship, when possible, but only if	**Upon disembarkation** • Test symptomatic patients by PCR upon arrival in port	**On board the ship** • Isolate patients in the sickbay, or in a single cabin, and wear medical masks when in contact with other people. The patient should have access to a bathroom not used by others • Use PPE when entering the room of an infected person • Identify and test all close contacts • Maintain high level cleaning and disinfection measures during ongoing on-board case management • Treat laundry, food service utensils and waste from cabins of possible cases and close contacts as impossible	**Surveillance** • Report cases to the next port of call

	conditions and circumstances permit and it is safe to do so • Disinfect own work areas, equipment, and tools as appropriate after use • Refrain from using any common areas on board, such as the mess/day room, laundry area or recreational areas when being used by others, unless special arrangements or measures are in place • Return to cabin immediately after completing work hours • Remain in cabin during rest hours, except when arrangements or measures are in place to spend some rest time on deck • Receive and eat all meals in cabin, provided it is safe to do so **Prior to / Upon disembarkation** • Monitor health prior to disembarkation		**Prior to disembarkation** • Pre-plan disembarkation of possible case to avoid contact with other passengers or crew **Upon disembarkation** • Thoroughly clean and disinfect isolation cabin or quarters after a patient has disembarked • Quarantine unvaccinated seafarers away from ship	

By: CDC **Title:** *Cruise Ship Travel During COVID-19 (2022)*[82]	**Before/ Upon embarkation** • Be up to date with COVID-19 vaccines • Get tested before embarkation **On board the ship** • Wash your hands often with soap and water or use hand sanitizer with at least 60% alcohol. • Follow recommendations for protecting yourself and others Follow any ship-specific mask protocols		**On board the ship** • Stay in your cabin if you have signs and symptoms of COVID-19 – notify the onboard medical center immediately	**After Cruise** • Self-monitor for symptoms of COVID-19 • Get tested for current infection with a COVID-19 viral test 3–5 days after your trip or if you develop symptoms Isolate if you develop symptoms or your test result is positive
By: CDC et al. **Title**: *Guidance for Cruise Ships on the Mitigation and Management of COVID-19 (2022)* [83]	**Before/ Upon embarkation** • Promote vaccination of crew and passengers on board the ship • Screen passengers for signs or symptoms of COVID-19, known close contact exposure to a person with COVID-19 within the 10 days before embarkation, or a positive COVID-19 viral test within the 10 days before embarkation	**Before/ Upon embarkation** • Perform day-of-embarkation screening for signs and symptoms of COVID-19 and COVID-19 testing of travelers • Test newly embarking crew on the day of embarkation and	**On board the ship** • Maintain and apply isolation and quarantine protocols, including how to increase capacity in case of an outbreak • Minimize contact between travelers in quarantine and/or isolation and support staff • Isolate all passengers with signs and symptoms of COVID-19	**Management** • Avoid medical evacuations at sea to the extent possible • Contact emergency medical services while at port for exigent circumstances • Perform emergency medical transportation of critically ill persons with suspected or confirmed COVID-19 from the ship

	• Consider requiring travelers to get tested for current infection with a viral test as close to the time of departure as possible (no more than 3 days before travel) and present negative test result prior to boarding **On board the ship** • Maintain and apply procedures for routine and outbreak-level cleaning in areas where travelers are reasonably expected to gather or otherwise use • Encourage crew to wear masks in indoor areas or when interacting with port personnel • Encourage wearing masks indoors or when outside individual cabins • Promote hand hygiene and cough etiquette • Discourage handshaking • Ensure access to hand sanitizers • Consider strategies to improve ventilation of indoor areas and maximize use of outdoor spaces • Implement physical distancing to avoid crowding of crew members	again 3-5 days after embarkation **On board the ship** • Maintain screening and surveillance protocols to detect covid-like illness and COVID-19 among travelers • Align testing protocols with CDC guidance • Maintain onboard capacity to conduct viral tests for SARS-CoV-2 Perform routine COVID-19 Screening Testing and Monitoring of All Crew	• Identify and test close contacts as soon as possible • Isolate or quarantine travelers in single-occupancy cabins, with private bathrooms, with the door closed • Designate isolation and quarantine cabins in areas separate from other cabins • Ensure isolated travelers do not have direct contact with other travelers except for designated medical staff • Ensure designated medical staff or other personnel wear proper PPE • Deliver meals to individual cabins with no face-to-face interaction during service • Ensure cabins housing isolated or quarantined travelers are not cleaned by crew members • Use surveillance cameras or security personnel to ensure compliance with isolation or quarantine protocols	to a shoreside medical facility • Maintain plan to take the ship out of service if required **Surveillance** • Submit daily the Enhanced Data Collection (EDC) During COVID-19 Pandemic Form • Alternatively, report individual cases of COVID-19 via the Maritime Illness and Death Investigation form. • Maintain surveillance logs • Maintain documentation of SARS-COV-2 viral test results • Maintain plan to take the ship out of service if required

	when working or moving through the ship • Reduce face-to-face interactions between crew and passengers to the extent practicable • Modify meal service to facilitate physical distancing • Clean/disinfect frequently touched surfaces regularly • Change restaurant and bar layouts to avoid crowding between parties • Limit seating capacity • Discourage crowded waiting areas • Provide and encourage outdoor dining and bar/beverage service options • Provide and encourage in-room passenger dining service • Consider options for consumers to order ahead of time to limit the amount of time spent in the restaurant • Use touchless payment options as much as possible • Limit elevator capacity and capacity in entertainment venues and activities • Consider adding supplemental air ventilation		**Prior to/Upon disembarkation** • Maintain procedures to disembark passengers that require higher level of care • Define separate disembarkation procedures in case of a COVID-19 out break on board the ship • Ensure a separate pathway or sanitary corridor where the disembarking traveler will exit with their personal belongings such as luggage • Manage shoreside housing needs of patients and contacts in need of continued quarantine or isolation post disembarkation	

	or local air treatment devices in frequently used elevator cars • Improve ventilation in casinos and increase space between seats and gaming equipment and limit capacity • Set up physical barriers to avoid crowding **On the shore** Ensure all shore excursion tour companies facilitate physical distancing to avoid crowding			
By: CDC **Title:** *Interim Guidance for Ships on Managing Suspected or Confirmed Cases of Coronavirus Disease 2019 (COVID-19) (2022)* [28]	**Before/Upon embarkation** • Consider quarantine for embarking crew • Encourage vaccination among crew • Deny boarding to people with signs and symptoms of COVID-19 irrespective of vaccination status • Assess whether to deny boarding to close contacts (e.g., with a 10-day quarantine)	• Screen embarking and disembarking crew and non-crew • Monitor crew and non-crew onboard for signs and symptoms • Test for COVID-19 (onboard or onshore)	**On board the ship** • Implement onboard isolation, quarantine, and physical distancing • Modify meal service to facilitate social distancing if cases are identified onboard the ship • Eliminate self-serve option on board	**Management** • Maintain or secure access to adequate medical staffing • Arrange for onshore evaluation and hospitalization **Surveillance** • Maintain a system to notify nation, state, and local health authorities

	On board the ship • Train all crew on COVID-19 prevention and mitigation • Maintain enough PPEs • Encourage crew to wear masks in indoor areas or when interacting with port personnel • Encourage wearing masks indoors or when outside individual cabins • Promote hand hygiene and cough etiquette • Discourage handshaking • Ensure access to hand sanitizers • Avoid sharing personal items • Clean and disinfect all high touch surfaces Do not shake dirty laundry		**Prior to/Upon disembarkation** • Minimize shore leave	
By: CDC et al. **Title:** *Ship Crew Well-Being During COVID-19 (2021)* [84]	**Before/Upon embarkation** • Get fully vaccinated **On board the ship** • Wear a mask to keep your nose and mouth covered in public settings • Avoid close contact with anyone who is sick	• Test for COVID-19	**On board the ship** • If you feel sick, stay in your cabin, and tell your ship's medical staff, your supervisor, or your captain Follow isolation and quarantine protocols when advised to do	

	• Avoid touching eyes, nose, mouth with unwashed hands • Wash hands often with soap and water • Participate in daily temperature checks • Follow isolation and quarantine protocols when advised to do so • Clean high touch surfaces daily or as needed • Wear PPE as required • Use gloves as instructed and wash hands after you remove the gloves Prioritize mental health and sleep			
By: CDC **Title:** *Technical Instructions for Mitigation of COVID-19 Among Cruise Ship Crew (2021)*[85]	**Before/ Upon embarkation** • Explore options to vaccinate crew for COVID-19 (if person is eligible and vaccine available) **On board the ship** • Relocate all crew to single-occupancy cabins with private bathrooms • Instruct crew members to remain in cabins as much as possible during non-working hours	**Shoreside COVID-19 Laboratory Screening Testing of All Crew** • Test all specimens for a ship's crew at the same laboratory • Report all laboratory results in aggregate to CDC through the Enhanced Data Collection (EDC) form	**Before /Upon embarkation** • Quarantine all embarking land-based crew for 14 days **On board the ship** • Isolate and re-evaluate symptomatic crew, including through retesting, regardless of prior positive test results • Self-isolate immediately & inform the onboard	**Surveillance** • Submit "Enhanced Data Collection (EDC) During COVID-19 Pandemic Form" daily • Continue to report to USCG via Advance Notice of Vessel Arrival (ANVA) **Medical management** • Maintain adequate supplies of antipyretics

	• Cancel all face-to-face employee meetings, group events (such as employee trainings), or social gatherings • Instruct crew members to wear a face mask when outside of individual cabins • Close all crew bars, gyms, and other group settings • Implement social distancing of crew members when working or moving through the ship • Modify meal service to facilitate social distancing (e.g., reconfigure dining room seating, stagger mealtimes, encourage in-cabin dining) • Eliminate self-serve dining options at all crew and officer messes • Discourage handshaking – encourage the use of non-contact methods of greeting • Promote respiratory and hand hygiene and cough etiquette • Place hand sanitizer (containing at least 60% alcohol) in multiple locations and in sufficient quantities to encourage hand hygiene	**Screening Testing of All Newly Embarking Crew** • Collect specimens for SARS-CoV-2 testing from all newly embarking land-based crew **Routine Screening Testing according to ship color code** • After the completion of the initial 60-day crew testing requirement, require laboratory testing for every crew member conducted on a weekly basis or at such other intervals as required by CDC **On board the ship** • Monitor crew daily for signs and symptoms of COVID-19. If cruise ship operators can provide thermometers, self-temperature checks are preferable	medical center if fever (100.4°F / 38°C or higher), feeling feverish, developing acute respiratory symptoms or other symptoms of COVID-19 • Isolate or quarantine crew in single-occupancy cabins, with private bathrooms, with the door closed • Have no direct contact with other crew except for designated medical staff (the latter should wear protective equipment) • Package meals in disposable dining ware with single-use cutlery and deliver to individual cabins with no face-to-face interaction • Do not have cabins housing isolated or quarantined crew cleaned by other crew members • Have food waste and other trash collected by the isolated or quarantined crew member and placed outside the cabin during designated times for transport to the waste	(e.g., acetaminophen and ibuprofen), antiviral and antimicrobial medications, oral and intravenous steroids, and supplemental oxygen • Avoid medical evacuations at sea to the extent possible for either COVID-19 and non-COVID-19- related medical reasons

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	• Ensure handwashing facilities are well-stocked with soap and paper towels • Place posters that encourage hand hygiene to help stop the spread in high-trafficked areas • Implement routine cleaning and disinfection of surfaces • Do not shake dirty laundry • Wash laundry at the warmest appropriate water setting for the items, and dry completely • Identify pathways to minimize risk of respiratory transmission • Clean and disinfect trolleys **Embarking Overnight Contractors and Overnight Visitors** • Require embarkation day testing • Require all contractors and visitors who are expected to remain onboard for more than 7 nights to quarantine for 14 days upon embarkation and be subject to all crew protocols	• Implement onboard testing capabilities to test all symptomatic travelers (crew and future passengers) and their close contacts **Medical personnel** Document all positive SARS-COV-2 test results in ships' medical records	management center for incineration or offloading. • Bag soiled linens and towels in water-soluble bags and place outside the cabin during designated times for transport to the laundry room. • Consider use of surveillance cameras or security personnel to ensure compliance with isolation or quarantine protocols wherever possible **Prior to/Upon disembarkation** • Complete the Attestation for Commercial Transportation of Disembarking Crew	

	Embarking Day Contractors and Day Visitors • Deny embarkation if exhibiting symptoms • Wear mask for duration of visit onboard the ship • Maintain appropriate social distancing • Observe proper hand hygiene Disinfect all areas exposed after disembarkation			
By: CDC **Title:** *Cruise Ship Color-Coding status guide (2021)*[86]	**If ship is green:** **Before/ Upon embarkation** • If the ship received ship-to-ship transfers within the past 14 days, crew must have come from a ship that was not Red. • Quarantine embarking land-based crew for 14 days upon embarkation	**If ship is yellow:** • If test results are available within one week, re-assess status using results and this flowchart If test results are not available within one week, ship is considered red		**If ship is green:** **Surveillance** Submit the Enhanced Data Collection (EDC) During COVID-19 Form daily to CDC
By: ECDC / EMSA **Title**: *COVID-19: EU guidance for cruise ship operations (2021)* [87]	**Before/Upon embarkation** • Promote vaccination of crew and passengers • Assess maximum number of passengers and crew that can be carried on board to be able to	**On board the ship** Implement testing policy and ensure testing capabilities onboard the ship. Compensate any limitations with	**On board the ship** • Implement isolation plan • Manage contaminated waste • Manage cleaning and disinfecting of contaminated spaces	**Readiness** • Ensure enough resources are available to implement the COVID-19 Company and Ship Management Plan

	implement all required health-related safety measures fully and effectively • Apply health screening protocols (pre-boarding, disembarkation, re-embarkation) **On board the ship** • Ensure physical distance • Promote hand hygiene • Promote use of PPEs • Ensure appropriate cleaning and disinfection, especially of high-touch areas • Include special considerations for spaces where some of the measures could be more difficult to implement • Consider special measures for the Heating, Ventilation and Air Conditioning (HVAC) systems Reduce to a minimum contact of passengers and crew with pilots, visitors etc.	agreements with testing laboratories onshore	• Apply measures to infected people on board the ship (food service and utensils, laundry, waste management) • Consider (worst case) putting ship on quarantine **Prior to/Upon disembarkation** • Minimize exposure to other passengers and crew during disembarkation of confirmed, possible or probable COVID-19 cases Arrange for repatriation of passengers and crew members	• Train personnel on procedures of the COVID-19 Company and Ship Management Plan **Management** • Collect Passenger/ Crew Locator Forms • Define high-risk and low-risk exposure contacts • Define and implement medical evacuation procedures

By: Healthy Gateways **Title:** *Guidelines for cruise ship operations in response to the COVID-19 pandemic (2022)* [88]	**Before/Upon embarkation** • Reduce the number of passengers and crew on board to ensure that measures related to physical distancing on board ships can be maintained • Advise passengers to get vaccinated at least two weeks before embarking • Request proof of vaccination status and assess validity upon boarding • Develop an exclusion policy regarding COVID-19 • Advise high risk groups to visit a doctor for pre-travel medical consultation to assess if they are fit to travel • Maintain pre-boarding screening processes **On board the ship** • Reduce face to face interactions • Operate outdoor children's play areas only, or promote their use over indoor play areas	**Before/Upon embarkation** • Screen travelers incoming to the country of embarkation • Implement secondary screening (in depth interview and testing) for travelers who have COVID-19 compatible signs or symptoms • Test incoming crew members **On board the ship** • Have adequate laboratory diagnostic testing capacity • Train medical staff on sample collection • Test crew members before resuming operations • Test crew members on board ship (every week if unvaccinated, every 2 weeks if vaccinated) • Increase frequency of testing of crew members in response	**Before/Upon embarkation** • Quarantine unvaccinated incoming crew for 5 days on board or ashore, then test, then ask to work for 5 days with high efficiency mask **On board the ship** • Test all contacts and implement quarantine while waiting for test results • Maintain enough isolation cabins (single occupancy) for confirmed COVID-19 cases among passengers and crew • (Vaccinated/ recovered contacts identified as close contacts) Wear protective mask, get tested on day 5 and self-monitor for symptoms • (Unvaccinated identified as close contacts) Maintain 5 days quarantine, and get tested on day 5 and wear protective mask for an additional 5 days • Monitor compliance with quarantine rules	**Surveillance** • Monitor epidemiological situation, rules, and restrictions worldwide • Report any cases to next port of call • Report aggregated data about COVID-19 cases in the "COVID-19 report form" of the EU Common Ship Sanitation Database (within 7 days after each voyage) **Management** • Maintain a written contingency plan/outbreak management plan for COVID-19 • Coordinate management of cases ashore, with ports of call Ensure with ports along the route that, if needed, repatriations and crew changes can be organized

	• Prevent overcrowding in entertainment venues • Wear masks and use disinfectants in hair salons and spas • Have Standard Operating Procedures (SOPs) for cleaning and disinfection covering all types of surfaces and materials, defining the disinfectants and the methods to be used • Maintain SOPs for cleaning and disinfection of body fluid spills in the environment • Maintain SOPs for laundry of linen and clothing • Maintain physical distance in gyms and disinfect exercise equipment • Promote electronic payments in commercial stores • Perform frequent hand hygiene (baggage handlers) • Prioritize advanced respiratory protection for use by crew members belonging to high-risk groups • Thoroughly clean and adequately ventilate cabins between cruises • Implement food safety rules	to clusters or outbreaks • Test passengers routinely, only if sailing with less than 95% of crew members and/or less than 95% of passengers on board vaccinated or recovered • Self-monitor any symptoms (crew) Maintain adequate supplies of testing kits and PPEs	• Isolate positive cases (crew and passengers) • Isolate/ quarantine possible cases and contacts • Define thresholds for initiating screening testing of the entire crew of the department of a suspect case and the entire crew on board the ship **Prior to/Upon disembarkation** • Arrange with port of call for quarantine facilities and procedures to be followed for unvaccinated close contacts	

	• Manage food and water safety • Ventilate indoor areas • Implement physical distancing • Limit interaction among passengers, among crew, and between crew and passengers • Apply personal hygiene rules • Maintain good hand hygiene • Promote respiratory etiquette • Prevent droplet transmission by using face masks • Use PPE			
By: Healthy Gateways **Title:** *Interim advice for preparedness and response to cases of COVID-19 at points of entry in the European Union (EU)/European Economic Area Member States* (MS) (2020) [89]	**On board the ship** • Clean and disinfect all areas using separate cloths and buckets • Dispose wastewater from cleaning as sewage • Use single-use, disposable cleaning equipment • Select appropriate cleaning option • Disinfect food preparation areas		**On board the ship** • Ventilate, clean, and disinfect medical facilities daily • Place temporary high-efficiency particulate-air (HEPA) filters over the vents • Avoid splashes when cleaning toilets, sinks and sanitary facilities • Clean public toilets and hand contact surfaces regularly • Steam clean or discard soiled mattresses	

			• Wash all textiles at a hot-water cycle (90°C) and add laundry detergent • Treat waste / food utensils from cabins of suspected cases or contacts as infectious	
By: WHO **Title:** *Operational considerations for managing COVID-19 cases/outbreak on board ships* (2020)[90]	**Before/Upon embarkation** • Implement pre-boarding screening **On board the ship** • Wear medical masks • Follow cough etiquette • Practice hand hygiene **Prior to/Upon disembarkation** • Cleaning and disinfection after disembarkation • Complete PLF pre disembarkation	**On board the ship** • Provide guidance on how to recognize signs & symptoms Remind procedures to be followed when a passenger or a crew member on board displays signs and symptoms indicative of acute respiratory disease	**On board the ship** • Activate outbreak management plan • Apply infection control measures • Perform contact tracing immediately after identifying suspected case • Isolate case in pre-defined ward • Quarantine all contacts for 14 days • If difficult to identify, all passengers are considered contacts **Prior to/Upon disembarkation** • Minimize exposure during disembarkation of infected cases	**Medical management** • Disembark and transfer suspected case to an onshore health care facility as soon as possible **Surveillance** • Inform port authority of cases on board ship Provide all requested information

Table 8: Recommendations and guidelines for public health management measures for **influenza**

Guidelines/recommendations (By whom, Link)	Prevention	Screening and diagnosis	Risk containment	Other
By: EU SHIPSAN ACT JOINT ACTION (20122103) **Title:** *European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. Second edition.* (2016) [91] And **EU SHIP SANITATIN TRAINING NETWORK – SHIPSAN TRAINET PROJECT (2007206)** **Title:** *European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger*	**Before/Upon embarkation** • Vaccinate crew (at least 50%) and passengers (in-risk groups), at least 2 weeks before voyage • Disseminate health questionnaire upon embarkation • Deny boarding if signs and symptoms or allow to board and quarantine **On board the ship** • Understand and implement measures to prevent disease: handwashing, coughing and sneezing etiquette, disposal of dirty tissues, social distancing, elimination of handshaking events	**On board the ship** • Educate crew to recognize signs and symptoms of influenza • Initiate case finding, upon identifying influenza outbreak • Have rapid diagnostic influenza tests available onboard the ship	**On board the ship** • Isolate all patients presenting with symptoms of ILI for at least 24 hours after they are free of fever • Follow protocols for disinfecting and cleaning materials which have been contaminated by body fluids • Use PPE appropriately – face masks and disposable gloves • Manage waste properly – infectious waste should be managed separately from other types of waste and labelled and disposed of separately • Avoid cross-contamination • Disembark ill persons together with their luggage, personal items,	**Surveillance** • Record standardized surveillance data for influenza like illness (ILI) in the ILI log of the ship medical log • Send a report to the next port of call, if infection or death has occurred on board the ship • In the EU, report possible, probable, and confirmed cases of influenza to competent authorities Inform port of call on number of people requiring hospitalization, number of clinical specimens to be sent for examination and any need for supplies

Ships. European Commission Directorate General for health and consumers (2011) [92]	• Focus on regular cleaning (and disinfection where needed) of the ship accommodation spaces **In case of pandemic** • Deny boarding • Require vaccination • Request and record epidemiological information		etc. from a separate area of the ship or at a separate time from which healthy persons disembark or embark for the next voyage **In case of pandemic** • Isolate cases for at least 24 hours after they are free of fever Consider quarantine of crew or passengers that are not displaying symptoms but are suspected to be infected	
By: CDC **Title**: *Guidance for Cruise Ships on Influenza-like Illness (ILI) Management (2016)* [93]	**Before/ Upon embarkation** • Get vaccinated annually for influenza (all crew members) • Get vaccinated at least 2 weeks before voyage of high risk for ILI passengers • Postpone travel when sick • Consider disallowing a traveler with ILI to embark until at least 24 hours after resolution of fever without fever-reducing medications	**On board the ship** • Consider clinical diagnosis of influenza	**On board the ship** • Implement respiratory hygiene and cough etiquette • Isolate passengers who embark with symptoms of ILI • Isolate passengers who become sick with ILI en route • If in common areas, affected passengers with ILI should practice social distancing and wear masks • Keep interaction with sick people as limited as possible	**Surveillance & Reporting** • Submit a cumulative ILI report (even if no deaths or ILI cases have occurred) preferably during the final 24 hours of the voyage or as soon as an outbreak is suspected

	On board the ship • Take everyday steps to protect yourselves and others while traveling • Practice respiratory hygiene and cough etiquette • Practice hand hygiene • Consider more frequent cleaning of commonly touched surfaces such as handrails, countertops, and doorknobs		• Avoid touching eyes, mouth, and nose • Monitor health of close contacts for 4-5 days post exposure • Consider early antiviral treatment to control an outbreak **Upon disembarkation** Stay inside home or hotel in the city of disembarkation and refrain from further travel until at least 24 hours after being free of fever without the use of fever-reducing medications	
By: CDC **Title**: *CDC Yellow Book 2020. Chapter 8: Cruise ship travel (2019)* [78]	**Before/ Upon embarkation** • Delay travel until no longer contagious • Get vaccinated at least 2 weeks before travel • Discuss antiviral treatment and chemoprophylaxis with health care provider before travel (for passengers at high-risk for complications) • Prevent ill passengers from boarding	**Before/ Upon embarkation** Perform medical screening during embarkation to identify ill passengers	**On board the ship** • If boarded, require ill patients to isolate Report respiratory illness to medical center promptly and follow isolation recommendations	**By: CDC** **Title**: *CDC Yellow Book 2020. Chapter 8: Cruise ship travel (2019)*

	On board the ship • Practice good respiratory hygiene and cough etiquette • Wash hands frequently with soap and water • If soap and water are not available, use an alcohol-based sanitizer that contains ≥60% alcohol • Avoid contact with ill people **Prior to/Upon disembarkation** • Follow safe food and water precautions when eating off the ship at ports of call			

Table 9: Recommendations and guidelines for public health management measures for **gastrointestinal infections (GI) outbreak**

Guidelines/recommendations (By whom, Link)	Prevention	Screening and diagnosis	Risk containment	Other
By: EU SHIPSAN ACT JOINT ACTION (20122103) **Title:** *European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. Second edition. (2016)* [91] and **EU SHIP SANITATIN TRAINING NETWORK - SHIPSAN TRAINET PROJECT (2007206)** **Title:** *European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. European Commission Directorate*	**On board the ship** • Promote effective hand hygiene – thorough hand washing • Apply standard cleaning and disinfection procedures • Have disinfectants against norovirus always available • Perform environmental cleaning (public toilets and hand contact surfaces) • Use PPE (disposable gloves) when cleaning **Level 0** • Request pre-embarkation health questionnaire • Provide information on reporting of symptoms • Provide instructions on hand washing and health advice	**On board the ship** • Diagnose as early as possible • Use pre-agreed questionnaire maintained in ship's medical center • Collect fecal specimens for analysis during every outbreak **Level 2** • Ensure clinical support to diagnose cases • Collect fecal specimens for analysis during every outbreak • Collect and analyze epidemiological data to identify the cause of outbreak • Investigate galleys, potable water supplies or recreational water areas	**On board the ship** • Isolate everyone presenting with GI symptoms – minimum 24 to preferably 48 hours • Provide hygiene and medical support in individual cabins of patients • Provide room service or beverages to them where appropriate • Isolate affected crew on their own – if more affected, they may isolate together • Apply standard cleaning and disinfection procedures • Apply standard protocol of body fluid spillage in public area	**Surveillance** Maintain and monitor GI log **Level 2** Declare an outbreak

General for health and consumers (2011) [92]	**Level 2** • Emphasize the need for people to shower before using recreational water amenities		**Level 0** • Have a protocol to disembark affected passengers **Level 1** • Confine symptomatic people to their cabins • Provide health advice to close contacts **Level 2** • Isolate affected people in their cabins until clear of symptoms for up to 24 hours (preferably 48 hours) and 48 hours for crew • Treat cases in their cabins wherever possible. • Provide hygiene advice to them and any contacts. Provide room service to them • Commence an enhanced cleaning regime • Stop self-service of food and beverages wherever possible	

			After outbreak Implement enhanced cleaning to mitigate risk of continuation of illness in next voyage	
By: CDC **Title:** *Vessel Sanitation Program 2018 Operations Manual (2018)* [94] ***Note:*** *On the table we present only information relevant to crew and passenger health protection. The Manual includes additional chapters on the technical management and assurance of potable water safety, recreational water facilities, food safety, integrated pest management, child activity centers, heating, ventilation and air conditioning systems, fountains, misting systems, humidifiers and showers, administrative guidelines (i.e., inspections) and annexes. Their presentation is beyond the remit of this SLR.*		**On board the ship** • Circulate questionnaires detailing activities and meal locations over past 72HRS prior to onset of disease • Ensure adequate supply of clinical specimens' containers Collect and analyze specimens before administering antibiotics	**On board the ship** • Isolate all food employees for a minimum of 48 HRS • Receive approval from medical staff before returning to work • Restrict exposure to symptomatic crew members • Isolate ill passengers • Advise symptomatic passengers of hygiene and handwashing facts and provide written handwashing and hygiene fact sheet	**Surveillance** • Maintain Acute Gastroenteritis (AGE) surveillance log • Maintain all records on board and available for review for 12 months • Assure protection of data Perform reporting according to the Manual

By: CDC **Title:** *CDC Yellow Book 2020. Chapter 8: Cruise ship travel (2019)* [78]	**Before/Upon embarkation** • Conduct medical screening during embarkation • Prevent ill passengers from boarding **On board the ship** • Wash hands with soap and water often, especially before eating and after using the restroom • If soap and water are not available, use an alcohol-based sanitizer that contains ≥60% alcohol • Follow safe food and water precautions when eating off the ship at ports of call Avoid contact with ill people		**On board the ship** • If boarded, require ill patients to isolate Call ship's medical center and follow cruise ship guidance regarding isolation and other infection-control measures, even for mild symptoms of a GI illness	
By: Norovirus Working Group. Health Protection Agency. MCA. **Title:** *Guidance for the Management of Norovirus Infection in Cruise Ships (2007)* [95]	**Before/Upon embarkation** • Prior to embarkation, distribute health questionnaire and information on norovirus • Screen symptomatic individuals and prevent from coming aboard	**On board the ship** • Administer standard assessment questionnaire as a guide to identify presumptive norovirus outbreaks • Collect fecal specimens for analysis	• Isolate individuals who are currently at high risk • Isolate and manage confirmed cases according to enteric risk assessment. Food handlers and medical staff should be quarantined for at least 48 hours following	**Surveillance & Reporting** • Maintain daily gastrointestinal surveillance log Report the outbreak to the Port Health Authority 24 hours before arrival

	On board the ship • Promote scrupulous personal hygiene • Promote hand washing with soap and water Establish vigorous cleaning program	Carry out an investigation into the food and beverage operations on board	resolution of their symptoms • (Passengers) Remain in own cabin until 24 hours after resolution of symptoms • Encourage use of cabin en-suite facilities for a further 24 hours (i.e., a total of 72 hours symptom-free) • Relocate unaffected cabin companions in alternate accommodation • Do not use communal facilities during isolation • Offer and advise to get room service • Consider need for other time limited control measures • Institute recommended environmental cleaning regime • Establish dedicated cleaning team for environmental cleaning and servicing of cabins of affected passengers • Use universal precautions by wearing disposable aprons and gloves when examining all patients with acute gastrointestinal symptoms	

			Upon Disembarkation • Separate passengers leaving the vessel and those about to board. It may be necessary to use separate halls or movable barriers to prevent cross contamination Accommodate sick patients in specified hotels until recovery	

Table 10: Recommendations and guidelines for public health management measures for **legionella outbreak**

Guidelines/recommendations (By whom, Link)	Prevention	Screening and diagnosis	Risk containment	Other
By: EU SHIPSAN ACT JOINT ACTION (20122103) **Title:** *European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. Second edition. (2016)* [91] **And** **EU SHIP SANITATIN TRAINING NETWORK - SHIPSAN TRAINET PROJECT (2007206)** **Title:** *European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. European Commission*	• Include provisions for Legionella control in any WSP established on board the ship • Maintain specific temperature in water system • Run all taps and showers in cabins for several minutes at least once a week if they are unoccupied and always prior to occupation • Clean to remove scale, salt, sediments, sludge, dirt and debris from the water tanks and distribution system • Apply disinfection to reduce the number of microorganisms in the water to levels that cannot cause harm • Establish a schedule for regular cleaning and disinfection of all water system components • Drain water before any repairs to pipes etc.	Confirm disease with microbiological diagnosis	• Close any facility considered source of infection • Collect pre-disinfection samples • Perform preliminary risk assessment of the ship's water systems • Review maintenance and monitoring regimes and records • Perform post-disinfection sampling from points representing different loops of the water systems **After disembarkation** Initiate disinfection, repairs, change of filter media and others to avoid the recurrence of an outbreak in the next voyage	

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Directorate General for health and consumers (2011) [92]	• Wear PPE before cleaning • Perform regular sampling of water at least every 6 months • Consider special measures for hot tubes and spa pools • Construct air handling and conditioning systems to avoid accumulation of water in ducts and allow cleaning and disinfection • Inspect filters of air conditioning regularly • Inspect drains regularly Humidify by steam injection			
By: CDC **Title:** *CDC Yellow Book 2020. Chapter 8: Cruise ship travel (2019)* [78]	• Wash hands frequently with soap and water • If soap and water are not available, use an alcohol-based sanitizer that contains ≥60% alcohol • Follow safe food and water precautions when eating off the ship at ports of call • Avoid contact with ill people	• Perform Legionella urine antigen testing • Culture lower respiratory secretions on selective media, which is important for detection of non–L. pneumophila serogroup 1 species and serogroups and is useful for comparing clinical isolates to environmental isolates during an outbreak investigation Administer prompt antibiotic treatment		**Surveillance& Reporting** Quickly report cases of Legionnaires' disease to public health officials to determine if there are links to previously reported cases and to stop potential clusters and new outbreaks

Table 11: Consolidation of recommendations for **COVID-19 outbreak** – by public health pillar

	ICS (2022) [81]	CDC (2022) [28]	CDC et al. (2022) [83]	ECDC/ EMCA (2021) [87]	HEALTHY GATEWAYS (2020, 2022) [88, 89]	WHO (2020) [90]
Prevention						
Before/Upon embarkation						
Assess maximum number of passengers and crew to implement health related safety measures				X	X	
Promote vaccination of crew and passengers before boarding		X	X	X	X	
Relocate all crew to single occupancy cabins			X			
Scan / measure temperature	X	X		X	X	X
Screen for signs &symptoms	X	X		X	X	X
Scan for close contact with case prior to boarding the ship	X	X		X	X	X
Request viral test / present negative test result prior to boarding		X				
Request proof of vaccination status and assess validity before boarding					X	

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Advise pre-travel medical consultation					X	
Complete locator card	X			X		
Deny embarkation to those experiencing signs & symptoms	X		X			
Develop an exclusion policy for COVID-19					X	
On board the ship						
Enforce / promote hand hygiene	X	X	X	X	X	X
Discourage hand shaking		X	X			
Ensure access to hand sanitizers		X	X			
Enforce /promote cough etiquette	X	X	X	X	X	X
Wear medical masks (indoors / when interacting with port)	X	X	X	X	X	X
Promote use of PPEs			X	X	X	
Set up physical barriers to avoid crowding		X				
Maintain physical distancing – avoid all non-essential contact	X	X		X	X	X
Maintain physical distancing in gyms and disinfect exercise equipment					X	

Reduce face-to-face interactions between passengers and crew		X		X	X	
Modify meal service to facilitate social distancing		X				
Implement food safety rules					X	
Change restaurant and bar layouts to avoid crowding between parties		X				
Limit seating capacity		X				
Discourage crowded waiting areas		X				
Consider options for passengers to order ahead of time to avoid crowding		X				
Limit elevator capacity and capacity in entertainment venues / activities		X			X	
Increase space between seats and gaming equipment in casinos		X				
Improve ventilation in indoor areas		X		X	X	
Consider adding supplemental air ventilation or air treatment devices		X				
Improve ventilation in casinos		X				

Thoroughly ventilate cabins between cruises					X	
Use outdoor areas, external stairway /escape routes and walkways	X	X			X	
Provide and encourage outdoor dining and bar/beverage service		X				
Provide and encourage in-room dining service		X				
Implement strict cleaning and disinfection protocols (SOPs)	X	X		X	X	
Clean/disinfect frequently touched surfaces regularly		X	X	X	X	
Clean/disinfect using separate cloths and buckets					X	
Use single-use, disposable cleaning equipment					X	
Dispose wastewater from cleaning as sewage					X	
Disinfect exercise equipment in gyms					X	
Disinfect food preparation areas / trolleys			X		X	
Wear masks and use disinfectants in hair salons					X	
Maintain SOPs for laundry of linen and clothing					X	

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Wash all textiles at a hot-water cycle (90°C) and add laundry detergent			X		X	
Do not shake dirty laundry			X			
Use touchless payment options		X			X	
Specifically for crew						
Refrain from using common areas on board (crew)	X		X			
Cancel all face-to-face employee meetings			X			
Instruct crew members to wear mask when outside of cabins			X			
Close all crew bars			X			
Implement social distancing of crew members when working			X			
Disinfect own work areas (crew)	X					
Return to cabin immediately after work hours (crew)	X					
Remain in cabin during rest hours (crew)	X					
Receive and eat all meals in cabin (crew)	X		X			

Prioritize advanced respiratory protection by crew belonging to high-risk groups					X	
Prior to/ Upon disembarkation						
Monitor health prior to disembarkation	X					
Ensure all shore excursion tour companies facilitate physical distancing		X				
Complete PLF pre disembarkation						X
Clean and disinfect after disembarkation						X
Screening and Diagnosis						
Before/Upon embarkation						
Perform day of embarkation screening for signs & symptoms		X	X			
Test newly embarking crew on day of embarkation and 3-5 days thereafter		X	X			
Screen embarking and disembarking crew and non-crew				X		
Require al contractors and visitors expected to remain on board ≥7 nights to quarantine			X			
Test all specimens for a ship’s crew at same laboratory			X			

On board the ship						
Maintain screening and surveillance protocols to detect covid-like illness		X	X			X
Align testing protocols with CDC guidance		X				
Maintain on board capacity to conduct viral tests for SARS-COV-2		X	X	X		
Compensate any limitations in capacity with agreements with testing facilities on shore				X		
Perform routine-COVID-19 screening testing and monitoring of crew		X	X	X		
Prior to/ Upon disembarkation						
Test symptomatic passengers by PCR upon arrival in port	X					
Risk containment / mitigation						
Before/Upon embarkation						
Quarantine all embarking land-based crew for 14 days			X			
On board the ship						
Designate isolation/ quarantine cabins in areas separate from other cabins		X	X	X		X

Isolate patients in sick bay or single cabins with private bathroom	X	X	X			
Minimize contact between travelers in quarantine and support staff		X				
Deliver meals to individual cabins with no face-to-face interaction		X	X	X		
Package meals in disposable dining ware with single use cutlery			X			
Wear PPE when in contact with sick patients / entering their room	X	X				
Identify and test all close contacts, as soon as possible	X	X				X
Quarantine all contacts for 14 days						X
If difficult to identify, all passengers are considered contacts						X
Define high risk and low risk exposure contacts				X		
Maintain strict cleaning and disinfection during case management	X			X		
Disinfect medical facilities daily					X	

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Avoid splashes when cleaning toilets, sinks and sanitary facilities					**X**	
Steam clean or discard soiled mattresses					**X**	
Ensure cabins housing isolated passengers are not cleaned by crew members		**X**	**X**			
Manage contaminated waste			**X**	**X**		
Treat food waste from cabins of suspected cases or contacts as infectious					**X**	
Manage soiled linens and towels			**X**			
Place temporary HEPA filters over the vents					**X**	
Use surveillance cameras to ensure compliance with quarantine protocols		**X**	**X**			
Consider putting ship on quarantine (worst case measure)				**X**		
Prior to/ Upon disembarkation						
Ensure no contact of case with other passengers during disembarkation	**X**	**X**		**X**		**X**
Ensure separate pathway to disembark with personal belongings (luggage)		**X**				

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Thoroughly clean and disinfect isolation cabin	X					
Quarantine unvaccinated seafarers away from ship	X					
Arrange for repatriation of passengers and crew				X		
Complete Attestation for Commercial Transportation of Disembarking Crew			X			

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Table 12: Consolidation of recommendations for **influenza outbreak** – by public health pillar

	SHIPSAN (2016, 2011) [91, 92]	CDC (2016) [93]	CDC (2019)[78]
Prevention			
Before / Upon Embarkation			
Get vaccinated annually for influenza		X	
Vaccinate crew and passengers at least 2 weeks before voyage	X	X	X
Disseminate health questionnaire upon embarkation	X		
Deny boarding if signs & symptoms	X	X	X
Postpone travel when sick		X	X
Discuss antiviral treatment and chemoprophylaxis before travel			X
In case of pandemic, deny boarding	X		
In case of pandemic, request vaccination	X		
In case of pandemic, request and record epidemiological information	X		
On board the ship			

Implement hand washing / hand hygiene	X	X	X
Implement cough and sneezing etiquette	X	X	X
Implement disposal of dirty tissues protocol	X		
Implement social distancing	X		X
Eliminate handshaking events	X		
Focus on regular cleaning and disinfection of ship accommodation spaces	X	X	
Prior to/ Upon disembarkation			
Follow safe food and water precautions when eating off the ship			X
Screening and Diagnosis			
Before / Upon Embarkation			
Educate crew to recognize signs and symptoms	X		
Perform medical screening during embarkation to identify ill passengers			X
On board the ship			
Initiate case finding, upon identifying influenza outbreak	X		
Have rapid diagnostic influenza tests available onboard the ship	X		

Consider clinical diagnosis of influenza		X	
Risk containment / mitigation			
On board the ship			
Isolate patients presenting symptoms for at least 24 HRS after free of fever	X	X	X
Isolate passengers who embark with symptoms of ILI		X	X
Isolate passengers who become sick with ILI en route		X	
Implement respiratory hygiene and cough etiquette		X	
If in common areas, affected passengers should practice social distancing/wear masks		X	
Keep interaction with sick people as limited as possible		X	
Avoid touching eyes, mouth, and nose		X	
Monitor health of close contacts for 4-5 days post exposure		X	
Follow protocols for disinfecting /cleaning materials contaminated by body fluids	X		
Use PPE (masks and disposable gloves) appropriately	X		
Manage waste properly (infectious waste managed separately)	X		
Avoid cross-contamination	X		

Consider early anti-retroviral treatment to control an outbreak		X	
Prior to/ Upon disembarkation			
Disembark ill persons together with luggage from separate area of ship	X		
In case of pandemic, isolate cases for at least 24 HRS after free of fever	X		
Consider quarantine of crew/passengers without symptoms but suspected to be infected	X		
Stay inside home or hotel in the city of disembarkation and refrain from further travel until at least 24 HRS after free of fever		X	

Table 13: Consolidation of recommendations for **gastrointestinal infections outbreak** – by public health pillar

	SHIPSAN (2016, 2011) [91, 92]	CDC (2016, 2018, 2019)[78, 93, 94]	HPA / MCA (2007) [95]
Prevention			
Before / Upon Embarkation			
Request pre-embarkation health questionnaire	X		X
Screen symptomatic individuals and prevent from coming aboard		X	X
Prevent ill patients from boarding		X	
On board the ship			
Promote effective hand hygiene – thorough hand washing	X	X	
Provide instructions on hand washing and health advice	X		
Apply standard cleaning and disinfection procedures	X		
Have disinfectants against norovirus always available	X	X	
Perform environmental cleaning	X		

Use PPE (disposable gloves) when cleaning	X		
Provide information on reporting of symptoms	X		
Provide instructions on hand washing and health advice	X		
Emphasize on need to shower before using recreational water amenities	X		
Avoid contact with ill people		X	
Prior to/ Upon disembarkation			
Follow safe food and water precautions when eating off the ship		X	
Screening and Diagnosis			
On board the ship			
Diagnose as early as possible	X		
Ensure clinical support to diagnose cases	X	X	
Use pre-agreed questionnaire maintained in ship's medical center	X	X	X
Collect fecal specimens for analysis during every outbreak	X	X	X
Collect and analyze epidemiological data to identify cause of outbreak	X		
Investigate galleys, potable water supplies or recreational water areas	X	X	X

Risk containment / mitigation			
On board the ship			
Isolate patients presenting with GI symptoms- minimum 24 – 48 HRS	X	X	X
Provide hygiene and medical support in individual cabins	X	X	
Isolate individuals who are at high risk		X	X
Isolate and manage confirmed cases according to enteric assessment			X
Keep passengers in own cabin until 24HRS after resolution of symptoms	X		X
Provide health advice to close contacts	X		
Encourage use of cabin ensuite facilities for a further 24 HRS			X
Relocate unaffected cabin companions in alternate accommodation			X
Do not use communal facilities during isolation			X
Offer and advise to get room service	X		X
Stop self-service of food and beverages	X		
Consider need for time limited control measures			X
Institute recommended environmental cleaning regime / disinfection	X		X

Apply standard protocol of body fluid spillage in public area	X		
Establish dedicated cleaning team for environmental cleaning of cabins of affected passengers	X		X
Implement enhanced cleaning to mitigate risk of continuation in next voyage	X		
Use dispensable aprons and gloves when examining passengers with GI symptoms			X
Prior to/ Upon disembarkation			
Disembark ill persons together with luggage from separate area of ship			X
Accommodate sick patients in specified hotels until recovery			X

2.4 Discussion

This SLR reports on the prevalence and the impact of communicable diseases on board cruise ships, as well as the recommendations and guidelines to effectively manage them across the public health continuum, which includes prevention, screening and diagnosis, and risk containment/mitigation. Travelling on a cruise ship may hide a complex combination of health hazards. Travelers from diverse regions brought together in the often crowded, semi-enclosed environments onboard ships can facilitate the spread of person-to-person, foodborne, or waterborne diseases. Outbreaks on ships can be sustained for multiple voyages by transmission among crew members who remain onboard or by persistent environmental contamination. Additionally, port visits can expose travelers to local vector borne diseases.

Our SLR confirms that communicable disease events are the most reported while cruising, compared to other types of diseases and health hazards[26]. Marshall et al. [12], who combined reports from Barbados Port Health Department from 2009 to 2013, noted that communicable diseases were evident at a rate of approximately 15.7 cases/100,000 passengers and 24/100,000 crew. According to the CDC's Yellow book[78], which is based on surveillance and emergency reports, approximately 3%–11% of conditions reported to cruise ship medical centers are urgent or an emergency. Approximately 95% of illnesses are treated or managed onboard, and 5% require evacuation and shoreside consultation for medical, surgical, or dental problems. Roughly half of passengers who seek medical care are older than 65 years of age. Most medical center visits are due to acute illnesses, of which respiratory illnesses (19%–29%); seasickness (10%–25%); injuries from slips, trips, or falls (12%–18%); and gastrointestinal (GI) illness (9%–10%) are the most frequently reported diagnoses. Injuries appear to be the most frequently reported diagnosis (24% or 4.3 per 1,000 person days at sea) also amongst passengers of scientific cruises[96]. Death rates for cruise ship passengers, most often from cardiovascular events, are also reported as ranging from 0.6 to 9.8 deaths per million passenger-nights.

According to Huang et al. [41], the scientific literature on cruise diseases research covers 19 main categories of diseases and health hazards, of which the top five studied hazards are infectious diseases, accounting for 52.2%; public environmental occupational health, accounting for 43.5%; gastrointestinal infections, accounting for 42%; medicine general internal, accounting for 24.6%; immunology, accounting for 18.84%; and microbiology, accounting for 17.4%.

According to Leggat & Franklin[26], the ten most common diagnoses by organ system on cruise ships are respiratory (26%-29%), injury-related (12%-18%), gastrointestinal (12%-16%), nervous and sense organs (9%), cardiovascular (3%-7%), genitourinary (3%), musculoskeletal (3%), skin and subcutaneous tissue (3%-13%), endocrine and immune (0.8%), and mental disorders (0.7%).

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Most of the recent literature reports on SARS-CoV-2/COVID-19 on board cruise ships[38, 42, 54], influenza[17-19] and gastroenteritis[20-22]. In addition to these hazards, outbreaks of measles, rubella, varicella, meningococcal meningitis, hepatitis A, legionellosis, norovirus and other respiratory and gastrointestinal illnesses are reported on board cruise ships[77]. Such outbreaks represent a serious hazard, not only for their potentially dangerous health consequences, but also because of their high impact on ship human resources and infrastructure and of the high costs incurred by the industry to manage them. Therefore, diseases that may not be of the highest prevalence on board a cruise ship may ultimately result in significant negative impact on the cruise ship industry and the crew[26].

Legionellosis is such a disease, presenting a notable impact since it is a potentially fatal lung infection caused by the inhalation or possibly aspiration of warm, aerosolized water containing Legionella organisms[23, 25, 26]. Legionnaires' disease (also known as legionellosis) is a form of pneumonia that can be life-threatening. It is caused by a bacterium that thrives in water, and the disease is likely environmentally related. For example, the bacterium might be in water vapor emitted by an air conditioning system, meaning that everyone on the cruise ship is potentially exposed. There is another disease caused by the same bacterium called Pontiac fever, which causes influenza-like symptoms[23]. It was thought to be a non-contagious disease, but after 2016, there has been evidence of a possible inter-human contagion[97]. The negative influence of legionellosis on tourism have been witnessed by the increasing number of cases contacted on board cruise ships, which represent 20% of total[97].

All these four health hazards are included in the data synthesis presented in this SLR. We should underline that Hepatitis A and B are also mentioned as a common health hazard on board cruise ships by the WHO[77]. However, there is no quantitative evidence (i.e., prevalence, incidence, other epidemiological indicators) specifically reported for these conditions on board cruise ships, after 2015, in either scientific literature or WHO databases.

Further, seasonal infections are also very often and could lead to a pandemic, if not controlled. Dbouk and Drikakis[98] supported that two pandemic outbreaks per year are inevitable because they are directly linked to weather seasonality. The pandemic outbreaks are associated with changes in temperature, relative humidity, and wind speed independently of the season. The authors highlighted that epidemiological models must incorporate climate effects through the Airborne Infection Rate (AIR) index[98].

Overall, COVID-19 seems to monopolize the relevant literature in terms of both outbreak frequency and impact on ships and the industry. Lin et al. [99] highlighted the immense negative impact of the COVID-19 pandemic on cruise ships and industry, worldwide, which included a sharp decline in the number of cruise passengers, leading to a significant decrease in operating income and profits of cruise companies, while the debt-to-assets ratio and leverage ratio increased significantly.

The magnitude of the challenge that COVID-19 posed on the industry can be grasped by reviewing the literature on the number of COVID-19 cases relative to the number of cruise passengers landing. Ito et al. [35] reported a rate of 12.85% for the country of arrival and departure, whilst only 1.50% was reported at the port of call. It was, thus, estimated that the number of COVID-19 cases was 11.35% points higher than the number of cruise passengers landing at the country of arrival and departure. Furthermore, the COVID-19 infection rate, which expresses the number of COVID-19 cases per population, was 0.057% in the country of arrival and departure versus only 0.006% at the port of call. Overall, due to the increasing number of reported cases and the current pressure on medical systems of COVID-19 identified on board cruise ships, authorities continue to find it challenging to respond to potential outbreaks[48]. Additionally, safe evacuation, diversion, isolation, and repatriation of cruise ship passengers generate financial costs on governments at all levels[100].

Further, the sudden outbreak of COVID-19 in cruise ships, challenged every port state, which is considered a core link between cruise ships and port destinations[101, 102]. Ports play an integral part and have significant role in epidemic prevention and control[101]. For instance, the government's response to the outbreak of the Princess Diamond outbreak reflected the limitations of its emergency resources and the inadequacy of the Yokohama Port Epidemic Prevention Emergency Response Plan. It was mainly characterized by inadequate detection capacity, a single detection method, and limited medical reception capacity, which led to an increased risk of cross-infection[101-103]. Additionally, more than 60% of the world's cruise ships fly Flags of Convenience for ease of navigation and management[102], thus further complicating mitigation and control of infectious diseases on board the ship. The Diamond Princess's case, as an emergency response to the COVID-19 outbreak, highlighted the complexity of handling international public health incidents on cruise ships[101-103], including from the perspective of law[104] and underlined major deficiencies in terms of prevention, diagnosis, and response to health emergencies in international public health laws[105]. Such deficiencies could be addressed through strengthening rule based international cooperation with respect to information sharing and management, a more efficient supervisory mechanism, clarification of key rules over jurisdiction and distributions of obligations amongst port states[106].

Due to this high burden, COVID-19 catalyzed significant advancements and updates in both regulations and recommendations as well as prevention and risk mitigation approaches on board cruise ships. The cruise industry could be considered as one of the most intensely regulated industries. There are clear, well-defined common standards with rigorous enforcement by outside authorities, such as the International Maritime Organization (IMO) and other authorities[107]. Standardized and comprehensive regulations for safety, security, crewmember protections, health, and environmental performance should be implemented in every cruise ship to ensure safe traveling, both for the passengers and the crew, but also to avoid major disease outbreaks and future immense economic losses for the cruise companies[79, 108]. An average cruise ship undergoes plenty announced and unannounced safety inspections per year, involving hundreds of hours, to ensure it meets specific requirements set by competent authorities[107]. International regulators include the IMO, International Labor Organization (ILO), and the World Health Organization (WHO). Furthermore, other competent agencies, such as the US Coast Guard, the Centers for Disease Control and Prevention (CDC) and the Environmental Protection Agency (EPA), publish specific regulations and enforce compliance on ships entering or departing US ports[107]. According to our review, CDC may be recognized as an agency that publishes guidelines systematically and comprehensively, however, US oriented / applicable guidelines may not be relevant to other countries. In the EU, the EU Healthy Gateways guidelines[88] are the most recent, complete, and comprehensive guidelines (on COVID-19), in line with the WHO and CDC minimum standards.

Our SLR confirms that surveillance is considered central as regards health regulations on board cruise ships. It is a key component of events detection and monitoring[29] and allows for evidence-based decision making on board the ship and at the port of call. Early detection of events allows for timely implementation of public health measures, containment of hazards and prevention of further potential exposure. Elements essential to event detection include surveillance, the capacity to receive notifications sent by ships and the capacity to communicate with authorities at both local and national levels[29]. Surveillance of communicable diseases on board passenger ships is an essential tool for assessing the burden of communicable diseases and allowing early detection and management of outbreaks. Maintaining medical logs of communicable diseases and active monitoring of such hazards on board assists ships in identifying outbreaks and other events of public health concern and allows them to implement control measures rapidly and consistently[91]. To translate data thus gathered in ship logs into meaningful decision making, a wide range of epidemiological indicators is used, including frequency rates (e.g., prevalence, incidence, standardized incidence rates and mortality rates, etc.), disease attack and spread indicators (e.g., case infection ratio, fatality ratio, attack rate, R0, etc.) and correlation indices (e.g., hazard ratio, regression models and correlation r or rho, etc.) [17-22, 24, 39, 41, 47, 48, 50, 51, 53, 56, 58, 59, 61-63, 65-69, 74-76, 109].

Our SLR of available recommendations and guidelines categorized findings along the three key pillars of public health, management i.e., prevention, screening and diagnosis and risk mitigation or containment. Recommendations and guidelines were further categorized according to where they fall in the cruise continuum, defined as (a) before or upon embarkation on the ship, (b) on board the ship, during the cruise, and (c) prior to or upon disembarkation from the ship.

As regards prevention, our SLR confirms an array of recommendations and guidelines that cover most instances and events both before embarkation and during travel and disembarkation of passengers from cruise ships. As Tables 7 - 13 can attest, almost all regulating bodies have published recommendations on vaccination or medical consultation for chemoprophylaxis pre-boarding the ship, testing to defer travel if sick, and extensive screening with health questionnaire upon embarkation to define epidemiological profiles of boarding passengers and crew. Further, during travel, prevention centers around strict implementation of infection control guidelines and recommendations, including:

- promotion of frequent and meticulous hand hygiene and proper respiratory etiquette by all crew members and passengers, ensuring relevant supplies (e.g., soap, alcohol-based hand rub solution, disposable tissues, no-touch waste bins) are readily available,

- physical distancing of at least 1.5 meters (or otherwise as per national/local health authority requirements of the home port or the port of call). Additional mitigation measures may be implemented to limit contact/interaction between crew members and between crew members and passengers (e.g., installation of sneeze guards/transparent dividers, directional controls in high-traffic areas, staggering of workspaces to provide separation, etc.),
- appropriate use of medical face masks or respirators or equivalent personal protective equipment (PPE),
- cleaning and disinfection of surfaces and objects according to routine procedures and with increased frequency in areas and on surfaces that are frequently touched by crew members and passengers,
- education, regular training, and continuous risk communication on the importance of personal protective and environmental measures implemented on board,
- appropriate ventilation of closed environments,
- for waterborne diseases, such as legionellosis, scrupulous surveillance and technical monitoring of water management systems.

Overall, our SLR confirms that prevention measures are extensively detailed in most guidelines in a clear and enforceable manner and cover the range of events on board a cruise ship.

Equally, Tables 7 - 13 attest to extensive guidelines and recommendations on mitigating the risk of further contagion as a core component of an integrated public health strategy on board cruise ships. It is also suggested that such strategies are employed as early as possible to strengthen the resilience and pandemic prevention ability of both the individual ship affected and the cruise industry. More specifically, isolation and quarantine of affected persons sits at the core of risk mitigation recommendations on board a cruise ship. This is particularly important of unvaccinated persons identified as close contacts of people confirmed as COVID-19 cases. Isolation may require alterations in ship capacity and cabin layout, given the need to isolate potential healthy partners of passengers which are confirmed or suspected of carrying a communicable disease as well as the need to isolate affected people in single occupancy cabins, away from the areas where the rest of passengers and crew move. Further, to service these affected passengers in isolation, adaptation of the food and beverage service may be required, as well as of cleaning and disinfection protocols and regimes, all extensively detailed in published guidelines.

Additionally, the SLR confirmed the diagnosis of cases on board the ship is also well detailed in the literature of guidelines and recommendations. The latter make extensive reference to availability of viral tests / microbial analysis (legionellosis) for diagnosis, as well as the requirement of all testing to be performed in the same laboratory onshore (for crew) and of agreements to be in place to address any capacity constraints with regards to testing on board the vessel. Guidelines also refer to adequacy of medical staff being available on board

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to address any challenges related to the diagnosis of communicable disease outbreaks that may influence progression and impact of outbreaks. Due to the aging passengers and the isolation of the environment while cruising, these resources and services should be adequate, easily accessible and used properly[110].

On the contrary, screening, and early identification of communicable diseases on board the ship is less extensively detailed in guidelines and recommendations, despite the importance attached to the early identification as a prerequisite for risk mitigation. Screening and early identification is explicitly listed as priority for action, and there are references in self-monitoring of temperature, where available and feasible. Additionally, select literature[111] calls for PCR testing not only on embarkation but also daily, of all individuals aboard, together with increased social distancing and other public health measures to dramatically reduce the probability of onboard COVID-19 community-spread. Yet, guidelines reviewed do not make any reference to the introduction of e.g., wearables for monitoring health vitals amongst passengers and crew or sensors for early identification in change in those vitals that could indicate the onset of a communicable disease. Regarding the latter, biosensors are described as compact analytical devices, incorporating biological or biomimetic sensing elements that are applied for the detection and monitoring of various analytes or pathogens important for the environment, health, and food industries[112].

For example, very recent literature[113] discusses the development of a novel edge-centric healthcare framework integrating with wearable sensors and an advanced machine learning (ML) model for timely decisions on COVID-19 detection with minimum delay. The study relied on wearable sensors to collect a set of features that were further preprocessed for preparing a useful dataset. However, due to limited resource capacity, analyzing the features in resource-constrained edge devices was challenging. Motivated by this, the study introduced an advanced ML technique for data analysis at edge networks, namely Deep Transfer Learning (DTL), which transfers the knowledge from the well-trained model to a new lightweight ML model that can support the resource-constraint nature of distributed edge devices. The extensive simulation results demonstrated the efficiency of the proposed DTL technique over other existing ones and achieved 99.8% accuracy[113].

Further, piezoelectric and magneto-strictive biosensor materials have been shown to have a great potential for application in the detection of various viruses. More specifically, piezoelectric sensors are being used for the detection of human papilloma, vaccinia, dengue, Ebola, influenza A, human immunodeficiency, and hepatitis B viruses, whilst magneto-strictive sensors are being examined for the detection of bacterial spores, proteins, and classical swine fever[112]. Research has also been conducted on their use for example in COVID-19, but none of the commercially available options could be used for pandemic diseases[112]. Therefore, recommendations have been developed towards the biosensing community to enhance future usability of research outputs, including 10 requirements for biosensing devices[112], namely:

- they should be disposable and amenable to mass production,
- they should enable large scale population screening,

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- they should be easy to use by patients,
- they should be inexpensive and have portable readout unit,
- they should produce rapid results, enabling short time-to-result times (less than 1 hour),
- they should require low sample volumes and be easily accessible,
- they should be highly selective and sensitive,
- they should come with integrated sample preparation,
- they should be easily scalable and flexible to detect, and
- they should accommodate simultaneous detection of different analytes.

Improving modeling accuracy could further remarkably increase the efficiency of the structural optimization of computational interactions between mechanical and electromagnetic fields, thereby reducing the time and cost of manufacturing and tooling in such experiments. At the same time, such enhancement would also help determine the microscale/nanoscale mechanisms impacting both mechanical and electromagnetic behavior of the functional piezoelectric and magneto-strictive materials[112].

Further, extensive sanitation has become the primary approach in prevention and disruption of disease outbreaks. The search for new effective and sustainable approaches for infection control has recently led researchers to explore and reevaluate the innovative idea of using probiotics to “attack” surface pathogens[114]. Accumulation of studies of probiotic effect on pathogens on inmate surfaces have shown that introduction of certain probiotics strains can antagonize pathogen growth and reduce pathogen biofilm formation through mechanisms of competitive exclusion (competition over resources)[115]. Indeed, it was shown that Bacillus subtilis strains extracellular enzymes can effectively inhibit the infection of SARS-CoV-2 virus via spike protein degradation[116]. Continuous dispersion devices, which aerosol the spores and spread them through air, maintain a constant and automatic reapplication of environmental probiotics, thus cutting down human intervention to minimal. When incorporated into a HVAC system, they serve as a holistic solution that treats both all the indoor spaces connected to the HVAC system and simultaneously the HVAC system itself.

Overall, biosensing devices would need to be effectively and efficiently incorporated into the ship’s architecture. Design and construction of cruise ships is of major importance in terms of preventing an outbreak or mitigating the spread of the disease. The main routes of transmission of respiratory infections and health hazards, including COVID-19, on cruise ships is the person-to-person transmission, as well as other airways like aerosol transmission via central air supply or drainage systems[62]. Heating, ventilation, and air conditioning (HVAC) systems on cruise ships, if not used properly, may gravely impact on spread of communicable disease[117]. Confined environment enables higher rates of disease transmission[63]. Additionally, design of sanitary piping systems and waste disposal discharges on cruise ships increase the probability of disease transmission[118].

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The impact of air ventilation systems on airborne virus transmission (AVT), and aerosols in general, in confined spaces, is consistently examined in the literature[119, 120], though not yet fully understood[119]. The recent COVID-19 pandemic revealed the need to further comprehend the limitations of ventilation systems regarding AVT. Dbouk & Drikakis[120] explored three different flow scenarios regarding the position and operation of inlets and outlets in the elevator and a fourth scenario that includes the operation of an air purifier. The study confirmed that the position of the inlets and outlets has a sizeable impact, as it significantly affects the flow circulation and droplet dispersion. Additionally, an air purifier does not seem to eliminate airborne transmission and the droplet dispersion is reduced when a pair of an inlet and an outlet is implemented. Overall, it appeared that the placement and design of the air purifier and ventilation systems significantly affects the droplet dispersion and AVT, reflecting the fact that engineering designs of such systems should consider the flow dynamics and use computational modeling to develop more advanced epidemiological models.

Another recent study that aimed to explore solutions for reducing indoor virus transmission using air purifiers[121], revealed that the local positioning of a purifier indoors and the fan system embedded inside can significantly alter the indoor airborne virus transmission risk. The study suggested a new indoor air circulation system to better ensure indoor airborne viruses' local orientation is more efficient than a fan embedded in a standard domestic air purifier.

Dbouk & Drikakis[122] also investigated how airborne pollen pellets (or grains) can cause severe respiratory-related problems in humans. The authors found that in the case of high pollen grains concentrations in the air or during pollination in the spring, the social distance of 2 meters does not hold as a health safety measure for an outdoor crowd. Further, and as human cough is a common pathway for transmission, due to saliva particles transferring through airways[123, 124], it is critical to consider wind speed, temperature, and humidity before concluding on distancing public health measures, which should be even stricter for close spaces such as on cruise ships.

Further, Wang et al. [125] developed a multivariate linear regression analysis which revealed the contributions to air pollution of these five common health hazards, i.e., the volatilization of ship paint, volatilization of ship-based oil, cooking activities, high-temperature release of rubber components on the ship and daily use of chemical products, and the application of deodorant and insecticide, were 41.07%, 25.14%, 14.37%, 11.78%, and 7.63%, respectively.

Finally, Dbouk & Drikakis[126] found that thermal instabilities arising from the temperature gradients due to temperature differences between the indoor and outdoor environment spread the particles randomly indoors. This is adversely affecting air quality and architectural design. The authors recommended more efficient natural ventilation as the way to minimize aerosol pollutant particles dispersed indoors.

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2.5 Conclusion

This SLR focused on researching and reporting on the most frequent communicable diseases on board cruise ships to identify the health hazards that would need to be addressed throughout the implementation of the EU funded project HS4U tasks and deliverables, including the development of a pilot cabin that would help address public health challenges on board cruise ships.

The SLR, which reviewed available literature between 2015 and today, confirmed that the most frequent communicable diseases on board cruise ships are those already addressed in current guidelines and recommendations governing safe cruising, i.e., COVID-19, influenza, and gastrointestinal infections. Additionally, legionellosis has been deemed a high impact communicable disease on board cruise ships and was also included in this SLR.

Recommendations and guidelines to address these health hazards were also reviewed as part of this SLR and presented in tabular form according to recommending body and consolidated according to their content and where they fall on the public health management continuum, i.e., prevention, screening and diagnosis and risk mitigation/containment. Recommendations were also categorized according to when they are applicable, i.e., before embarkation, during travel, and prior to or during disembarkation.

The review of these recommendations confirmed that prevention and risk mitigation are exhaustively addressed in the current literature. Diagnosis is also adequately detailed, referring to availability and accessibility of diagnostic means and resources. Conversely, despite screening and early identification being cardinal in prompt diagnosis and effective risk mitigation, both of which are extensively presented as goals of public health interventions on board cruise ships, there appears to be limited reference to tools and methods to perform large scale screening and early identification amongst passengers and crew on board cruise ship. Such interventions would probably necessitate use of wearables or other biosensing devices that are to-date not included in the relevant literature.

This gap is expected to be addressed potentially through redesign of travel processes and cabin and space layout on cruise ships, within the remit of this EU funded project, HS4U. As part of the potential introduction of such tools and methods, it would also be critical to assess patient and crew willingness to adopt and comply with such recommendations and tools. In this light, any future research into such tools and methods will need to incorporate crew and passenger preferences to ensure optimal compliance with and, thus, optimal effectiveness of these interventions.

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3. Section 2. Workshop with internal stakeholders

3.1 Aims and outcomes of the workshop.

The findings of the Systematic Literature Review in 2.5, were presented to a Workshop with internal stakeholders. It is described in the Grant Agreement as the 1st Workshop with internal partners and it was conducted via the Zoom platform. The main goal of this meeting was to validate the practice gap identified by the SLR in screening and early detection of the most prevalent communicable diseases during a cruise, and to present to the cruise partners the technological solutions that may be considered to address this gap.

The list of participants, the agenda and the minutes of this workshop are presented in detail in Annex 1. The main outcomes of the meeting were:

- All the guidelines, which have been included in the SLR are validated,
- There is, indeed, a practice gap in screening and early detection that should be the target of this project,
- The most critical diseases to detect are COVID-19 and Norovirus (Gastrointestinal diseases),
- The consortium should contact the operations' department of the cruise companies to allocate the budget for each ship or per passenger for health-related actions,
- The ranking of technological solutions to be included in the stated preference surveys is:
    1. A smart wearable to report the health-related parameters,
    2. Outfitting the sinks and toilets with biosensors for COVID-19 and Norovirus,
    3. Design a mobile application which will be installed on passenger's mobiles for symptom tracking,
    4. Implementation of air quality monitoring applications in cabins,
    5. Coating the cabin furniture with anti-bacterial material,
    6. Installation of large screens with information and recommendation in case of a disease outbreak.
- There is an estimation of a 10 – 20% of passengers who would refuse the use of the proposed solutions, and
- The technology solutions should be combined with other procedures and guidelines of the cruise ship, i.e., there should be an encouragement to visit the ship's doctor, once the symptoms have been verified (from a biosensing device).

The discussion during the workshop informed the design of the stated preference surveys' questionnaires, to be discussed in the next section.

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4. Section 3. Stated preference surveys

4.1 Introduction

Following the outcomes of the workshop and in accordance with the findings of the SLR, two stated preference surveys (one for passengers and one for crew of cruise ships) were conducted.

Both surveys were cross-sectional studies to assess the preferences for and willingness of passengers and crew to endorse / implement technical state of the art solutions proposed by HS4U for the screening for and early detection of communicable diseases on board cruise ships.

Additional objectives were:

- To record barriers / concerns of passengers and crew that impact on their decision to endorse / implement technical state of the art solutions proposed by HS4U for the screening and early detection of communicable diseases.
- To correlate willingness and barriers / concerns of passengers and crew with their sociodemographic and baseline health status characteristics.

Data was collected from passengers and crew upon embarkation on consortium partner cruise ships.

Study primary endpoints were:

- Willingness to endorse/follow proposed state-of-the-art technical solutions, including use of imaging devices, biosensors in sinks and toilets, biosensors installed in the HVAC system for air quality monitoring, antibacterial materials on cabin’s surfaces, large monitors in public spaces and/or cabins with real-time guidance in case of a disease outbreak, daily visits to the ship's doctor’s office.
- Barriers / concerns to endorse/follow proposed state-of-the-art technical solutions, including worries about health data security, social stigma in case of illness, the effect of technical solutions on subject’s health, lack of comfort during the cruise, etc.

Secondary endpoints were:

- Association of demographic characteristics with willingness and barriers / concerns to endorse/follow proposed state-of-the-art solutions.

4.2 Rationale and Background

Deliverable 2.1. entitled "Mapping of existing framework conditions, challenges, system failures and gap analysis" defines current challenges in ship prevention, mitigation and management of health hazards and puts forward specific requirements for the HS4U-proposed solution in naval architecture. The first section of this deliverable included the preparation of a systematic literature review (SLR), which was conducted to address the following research questions:

1) What is the prevalence or frequency of the most common communicable health hazards on cruise ships?

2) What are the commonly used indicators to report on these communicable diseases on board cruise ships?

3) What is the burden or impact of these prevalent communicable diseases on cruise ships?

4) Are there available guidelines to prevent or manage outbreaks of these communicable diseases on board cruise ships?

The second task of Work Package 2 was to organize a workshop with the participation of the cruise ship partners of the consortium (internal workshop), setting the main goal of this meeting as to validate the practice gap identified by the SLR in screening and early detection of the most prevalent communicable diseases during a cruise, and to present to the cruise partners the technological solutions that may be considered to address this gap.

The SLR confirmed that the most prevalent and important diseases on board cruise ships (when viewed in combination with their public health impact and burden) are COVID-19, influenza, gastrointestinal infections, and legionnaire's disease.

With regards to the guidelines and recommendations aimed at addressing these, the SLR confirmed that prevention and risk mitigation are exhaustively addressed in the current literature. Diagnosis is also adequately detailed, referring to availability and accessibility of diagnostic means and resources.

Conversely, despite screening and early identification being cardinal in prompt diagnosis and effective risk mitigation, both of which are extensively presented as goals of public health interventions on board cruise ships, there appears to be limited reference to tools and methods to perform large scale screening and early identification amongst passengers and crew on board cruise ship.

The HS4U Consortium is putting forward a basket of technological solutions that are available to address this practice gap. The highest-ranking technological solution from the Consortium's point of view is the use of a smart wearable that would report on the health-related parameters of the wearer to the medical personnel of the ship. Secondly, a sink or toilet that would be outfitted with biosensors for norovirus and COVID. Thirdly, an application to be installed on passenger mobile phones that would support symptom tracking and urge

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for a visit to the ship's doctor, as required. Fourthly, applications to monitor air-quality in cabins. Fifth, coating of cabin furniture with anti-bacterial material. The last technological solution is the installation of large screens with information and recommendations of what the passengers should do in case they have symptoms of a specific disease.

These technical solutions will need to be endorsed and applied by passengers on board cruise ships and enforced or implemented by crew. To probe into their willingness to endorse or follow these proposed state of the art solutions as well as record any drivers and barriers for these preferences and discuss options to further strengthen acceptance of solutions, the Health Policy Institute conducted a stated preference survey in each of the two audience groups on board cruise ships.

Results of the survey will be used to inform Consortium partners of levels of acceptance of proposed solutions as well as any barriers and drivers to these preferences and propose mitigation actions to further strengthen acceptance of these solutions.

4.3 Research methods

This section details the methodology, study sample and proposed analysis approach for two surveys, one with passengers and one with crew, on board bruise ships, to assess and report on willingness to adopt/endorse proposed state of the art technical solutions to screen for and detect early communicable diseases outbreaks onboard cruise ships.

4.3.1 Study Design

This was a non-interventional, cross-sectional study with a random sample. Data was collected between April 2023 and May 2023 through paper questionnaires.

Instrument design

The content of the questionnaire was validated with WP3 and cruise partners during the internal workshop that took place on the 9th of January 2023. Items were generated from the discussion among the partners during this workshop, which evaluated the state-of-the-art technical solutions along with possible barriers / concerns to endorse/follow these.

The following state-of-the-art technical solutions were identified: use of imaging devices, biosensors in sinks and toilets, biosensors installed in the HVAC system for air quality monitoring, antibacterial materials on cabin's surfaces, large monitors in public spaces and/or cabins with real-time guidance in case of a disease outbreak. Also, the barriers / concerns that were identified were: worries about health data security, social stigma in case of illness, the effect of technical solutions on subject's health, lack of comfort during the cruise and unwillingness to be monitored.

Instrument construction and content validity, reliability

The preliminary version of the questionnaire was circulated to an internal advisory committee for feedback, i.e., to evaluate the overall format and items of the questionnaire. The committee was comprised of Dr. Berengère Lebental, Ms. Anna Kontini, Mr. Panagiotis Evangelou and Mr. Pambos Skapoullis. The questionnaire was revised through iterative feedback. Each expert was asked to assess the relevance of each question in the instrument. Content experts rated the relevance of each question/item in the questionnaire on a scale of 1 to 4. For the relevancy scale, a 4-point Likert scale was used and responses included: 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, and 4 = very relevant. Ratings of 1 and 2 were considered content invalid while ratings of 3 and 4 were considered content valid. The experts were specifically requested to provide recommendations (for revision or deletion) for each question which they had scored low (1 or 2). For the questions in need of revision, the experts had to comment on the clarity (how clearly the question was worded) and were requested to provide a possible option of ensuring the relevance of the question.

A rich and useful feedback was received from the members of the internal advisory committee, and the content of the questionnaire was modified in line with their suggestions. A couple of questions were removed completely, and others were rephrased to meet the Committee's suggestions. Moreover, the questionnaires were translated in two additional languages, Greek and French to reduce the exclusion criteria. Hence, the third selection criterion was modified into:

- Able to read and write either in English or in Greek or in French.

The exclusion criterion changed accordingly.

The final form of the questionnaires is presented in Annex 2.

The study protocol together with the questionnaires were then reviewed by the Ethics Committee Board and the Data Protection Officer and were approved without any changes on April 17th, 2023.

The test-retest reliability study was conducted after the content validation[127]. The questionnaire was distributed twice (one week apart) in 20 passengers/ crew and afterwards the reliability coefficients were computed, assuming that the questionnaire items were consistent across time.

4.3.2 Study population and procedures

The study sample consisted of cruise passengers and cruise ship employees (crew).

Selection of Subject

Adult passengers boarding a cruise ship to participate in a cruise and the ship's crew.

The minimum number of passengers to be included was defined as approximately 375.

The minimum number of ship's crew to be included was defined as approximately 200.

Selection Criteria

A subject was considered eligible for inclusion in this study, only if all the following criteria applied (inclusion criteria):

- Adults aged ≥18 years old,
- Able and willing to sign the informed consent form,
- Able to read and write either in English or in Greek or in French

Subjects were not eligible for inclusion in this study, if any of the following conditions applied (exclusion criteria):

- Aged less than 18 years old,
- Inability or unwillingness to give informed consent,
- Unable to read and write either in English or in Greek or in French.

Study Size Assessment

The primary endpoint was to estimate the proportion of passengers/crew that would be willing to endorse/follow proposed state-of-the-art solutions. The sample size was calculated considering this primary endpoint.

i. Passengers

The minimum sample size required was calculated using statistical power analysis[128]. For the proposed study, the experimental unit is the passengers, so sample size refers to the total number of individual passengers. The a-priori power analysis was based on the primary outcome of the study, represented as percentages of the endpoint. In order to increase study impact, the secondary endpoint (to explore if willingness of passengers and crew to endorse/follow proposed state-of-the-art solutions differs according to demographic characteristics) was also included in the calculation with equal significance.

Power analysis was performed using the G*Power software, version 3.1.9.6. Statistical power was set to 0.95, a value generally considered excellent for a non-interventional study. Assuming 50% of the subjects in the population or more would have the factor of interest (willing to endorse/follow proposed state-of-the-art solutions), and a population size of 3000 (passengers of two cruises), the study would require a minimum sample size of 350 for estimating the expected proportion with 5% absolute precision and 95% confidence.

To ensure a representative sample, a paper questionnaire was handed for completion to every 4th passenger boarding the cruise.

Concerning the secondary endpoint, it was calculated that with a sample size of 350 passengers the study would have 95% power (Figure 3) to perform a logistic regression analysis with dependent variables the study outcome (i.e willingness), at a significance level of 0.05 and for identifying an estimated odds ratio of 1.7 or more[129]. The protocol of power analysis is shown in the following figure:

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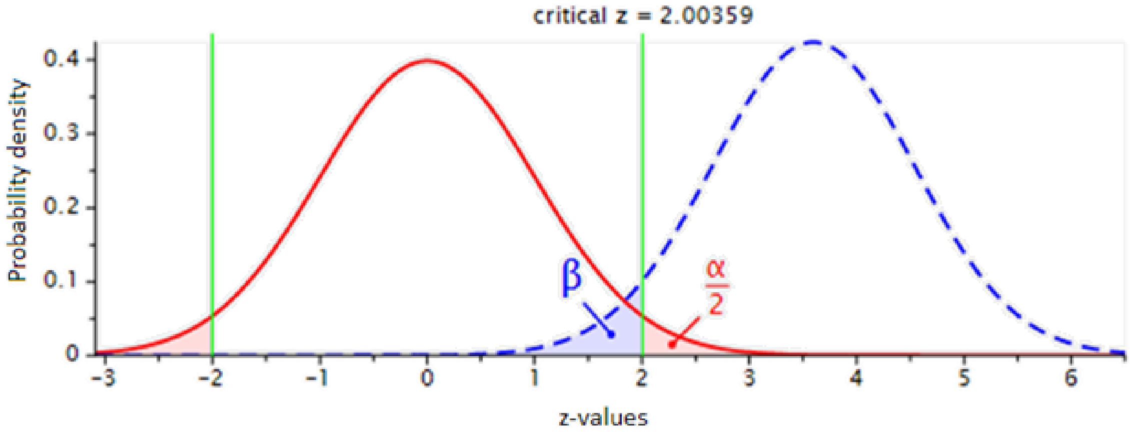

Figure 3: The figure illustrates the alpha (type I error) for the test and the beta (type II error). Also, the power is shown as it is defined as 1-beta.

ii. Crew

From the sampling population of about 580 persons working on the two cruises, a one-stage stratification was explored based on a professional criterion [stratification according to the working sector (i.e., deck, hotel, engine) each one employee belonged to]. The study sample was drawn – using alphabetical lists proportionately to the number of employees in each working sector. The final stratified random sample consisted of 200 employees who constitute about 35% of the total crew of the two cruises. Assuming 70% of the crew or more would be willing to endorse/follow proposed state-of-the-art solutions, and a population size of 580, the study required a minimum sample size of 200 persons for estimating the expected proportion with 5% absolute precision and 95% confidence.

4.3.3 Research Tool

The survey tool contained the following sections:

Participant characteristics

This section recorded basic anonymized participant demographics (Section 1, age, place of residence and educational level) and previous experience with cruising and awareness of / experience with communicable diseases on board cruise ships (Section 2).

Willingness to endorse state of the art solutions proposed by HS4U

This section probed into attitudes towards proposed state of the art solutions to screen for and detect early communicable diseases' outbreaks on board cruise ships.

4.3.4 Data Sources

Data were collected from passengers and crew directly by the cruise ship company (CELESTYAL) through paper questionnaires.

4.3.5 Data Management

Data collection was the responsibility of the cruise partner, in collaboration with the Health Policy Institute, and accurate documentation was the sole responsibility of the Health Policy Institute. The completed paper questionnaires were safely stored on board cruise ships, returned to designated cruise / administrative staff and, upon disembarkation, were handed to Health Policy Institute designated researchers for digitization. An Instructions Cover Note about the handling of the questionnaires to the passengers and crew was provided to the cruise partner. The Instructions Cover Note, presented in Annex 3, had to be read thoroughly by everybody whom the information therein concerned, and the instructions had to be followed, exactly.

4.3.6 Data Analysis

Descriptive analysis

Continuous variables are presented with mean, standard deviation, median, minimum, and maximum values. Quantitative variables are presented with absolute, relative frequencies and 95% Confidence Interval.

Univariate analysis

For the comparison of proportions chi-square and Fisher's exact tests were used. If the normality assumption was satisfied for the comparison of means between two groups, Student's t-tests were used. Mann-Whitney test were used for the comparison of continuous variables between two groups when the distribution was not normal. Spearman or Pearson correlations coefficients were used to explore the association of two continuous variables.

Data modelling

Multiple logistic regression models were performed to investigate the association of demographic and other characteristics with willingness and barriers / concerns of passengers and crew to endorse/follow proposed state-of-the-art solutions. Odds Ratios along with 95% Confidence Intervals were computed from the results of logistic regression analysis. Model diagnostics were evaluated using the Hosmer and Lemeshow statistic[130]. Hypothesized interactions of variables in the models were also tested.

Reliability and validity of the questionnaire

One proportion agreement method, the Content Validity Index (CVI)[127], was used to estimate quantitatively the content validity. To evaluate the reliability between the two measurements, intra-class coefficients (ICC) were computed. Internal consistency reliability[131] of the questionnaire was determined by the calculation of Cronbach's α coefficient[132]. Scales with reliabilities equal to or greater than 0.70 were considered acceptable. Exploratory factor analysis was also used to examine the structure of relationships between the items of the questionnaire and explore validation. All reported p values were two-tailed. Statistical significance was set at $p<0.05$ and analyses were conducted using SPSS statistical software (version 27.0).

4.4 Results and discussion

4.4.1 Data collection

The survey took place from 25/04 to 08/05 on board CELESTYAL Olympia. The test – retest reliability study described in 4.3.1, began on April 24th and lasted for 7 days. Having ensured the consistency of our data in time, the full survey started on May 1st and ended on May 8th, running on two successive cruises of the above-mentioned ship. 280 crew and 336 passengers' questionnaires were collected for analysis.

4.4.2 Data analysis

Sample consisted of 616 participants, of which 280 were crew members (45.5%) and 336 were passengers (54.5%). Crew members' demographic characteristics are presented in Table 14. Mean age was 37.5 years (SD=11.6 years). 75% were males and 42.1% were college graduates. 23.9% were from the Philippines and 22.5% from Indonesia.

Table 14: Crew demographic characteristics

Crew Demographic Characteristics		Number	Percentage (%)
Gender	Male	210	75.0
	Female	70	25.0
Age (mean, SD)	37.5 (11.6)		
Highest degree of Education	Less than high school degree	13	4.6
	High school degree or equivalent	80	28.6
	College degree	118	42.1
	Bachelor's degree	60	21.4
	Master's or PhD degree	9	3.2

Passengers' demographic characteristics are presented in Table 15. Mean age was 59.1 years (SD=14.2 years). 61% of the passengers were males and 35.1% held a bachelor's degree. Most of the passengers were from the USA (59.2%). 52.4% of the sample were employed/ self-employed and 41.4% were retired. Moreover, 64.9% of the sample were married or living with a partner (with or without children).

Table 15: Passengers' demographic characteristics

Passengers' Demographic Characteristics		Number	Percentage (%)
Gender	Male	131	39.0
	Female	205	61.0
Age (mean, SD)	59.1 (14.2)		
Highest degree of Education	Less than high school degree	18	5.4
	High school degree or equivalent	44	13.1
	College degree	66	19.6
	Bachelor's degree	118	35.1
	Master's or PhD degree	89	26.5
Employment status	Employed / Self employed	176	52.4
	Unemployed	18	5.4
	Retired	139	41.4
	Disabled, not able to work	1	0.3
	Other	2	0.6

To probe into level of familiarity with technological solutions, we inquired both crew and passengers after the extent to which they used technology per day. Responses are depicted in Table 16. Both crew and passengers reported using technology daily, mainly to perform work/duties, for entertainment purposes and for communicating with friends and family.

Table 16: Sample use of technology profile (crew and passengers)

How long on average do you use technology daily to perform the following tasks?	Crew N=280		Passengers N=336	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
To perform my work / duties	8.50 (3.60)	10 (10 - 10)	4.32 (2.8)	4 (4 - 4)
To keep up to date with news	0.74 (1.31)	0.5 (0.5 – 0.5)	1.16 (0.73)	1 (1 - 1)
To communicate with friends and family	1.20 (0.82)	1 (1 - 1)	1.33 (0.90)	1 (1 - 1)
To monitor my health vitals/ exercise routines / sleep patterns	1.29 (2.59)	0.5 (0.5 – 0.5)	0.81 (2.34)	0.5 (0.5 – 0.5)
For entertainment purposes (social media, subscription platforms etc.)	1.17 (0.94)	1 (1 - 1)	1.52 (1.47)	1 (1 - 2)

With regards to their experience with cruises, most of the sample had either been (63.4%) or worked (77.9%) on a cruise before, mostly more than 3 times. Almost three quarters of each sample subgroup had noticed any health or sanitation safety measures in place on board the ship, particularly for communicable diseases, (73.9% crew and 74.1% passengers). Of them, 77.9% of crew and 61.8% of passengers found those measures adequate and sufficient (Table 17).

Table 17: Experience with cruise and awareness of sanitation measures (crew and passengers)

Information on cruise experience		Crew N=280		Passengers N=336	
	Response	Number	%	Number	%
Have you noticed any health or sanitation safety measures in place on board the ship, particularly for communicable diseases?	No	73	26.1	87	25.9
	Yes	207	73.9	249	74.1
If yes, do you find them adequate & sufficient?	Yes	159	77.9	154	61.8
	Probably Yes	33	16.2	71	28.5
	I am not sure	11	5.4	15	6.0
	Probably No	0	0.0	7	2.8
	No	1	0.5	2	0.8

The vast majority of participants (both crew and passengers) were familiar with Covid-19, influenza, gastrointestinal diseases and legionella (Figure 4 and Figure 5). Most crew members (44.3%) and passengers (30.7%) were not afraid of contacting a communicable disease or infection on board the ship (Figure 6 and Figure 7).

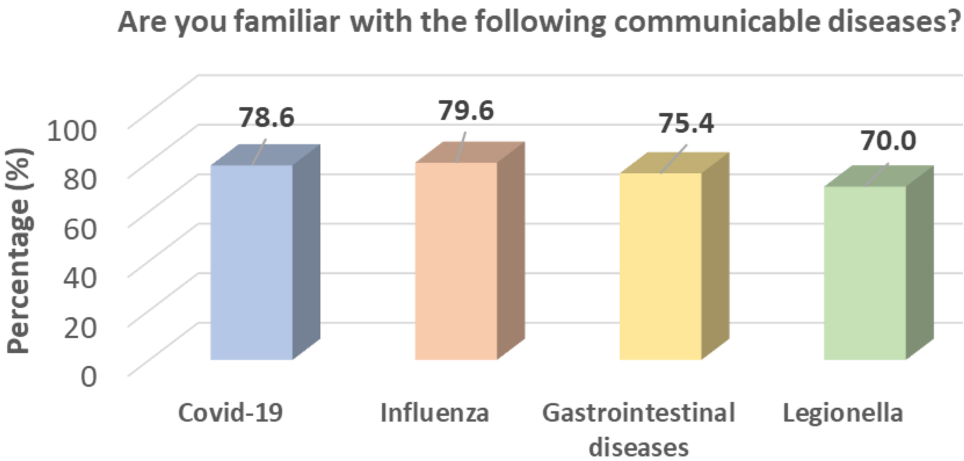

Figure 4: Familiarity with most prevalent communicable diseases (crew).

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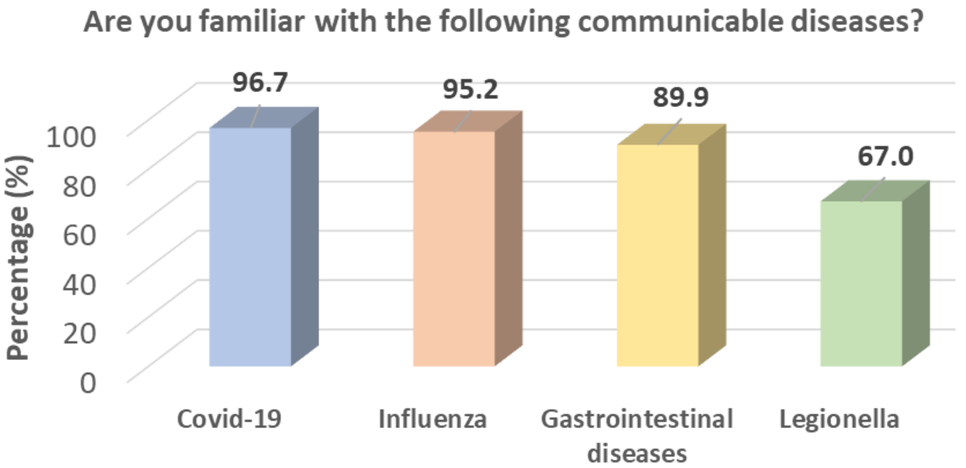

Figure 5: Familiarity with most prevalent communicable diseases (passengers).

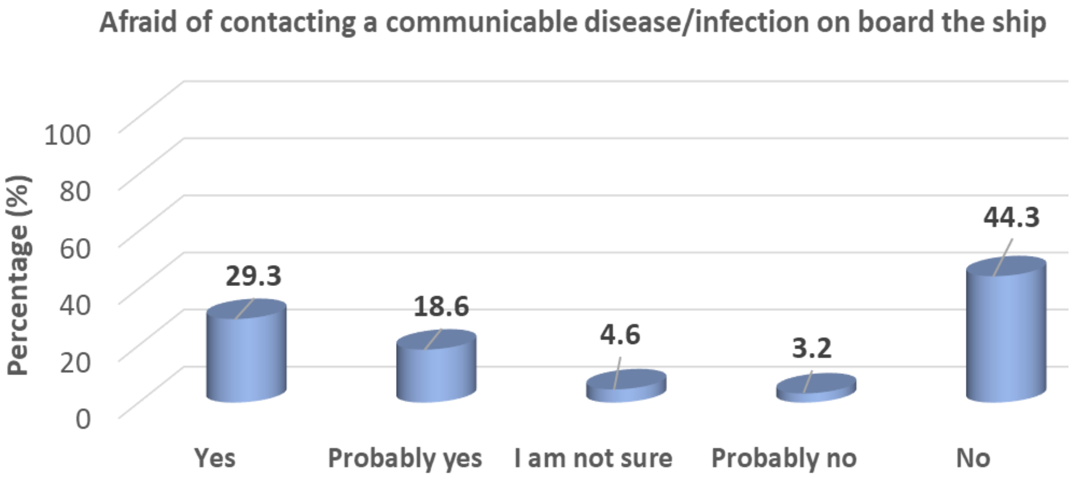

Figure 6: Fear of contacting communicable diseases on board the ship (crew).

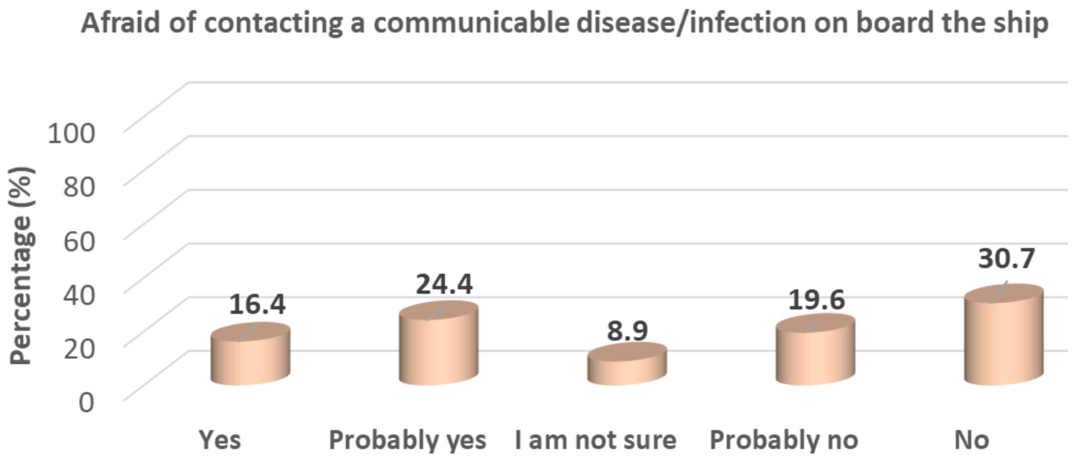

Figure 7: Fear of contacting communicable diseases on board the ship (passengers).

Participants' medical history is depicted in Figure 8, 5.4% of the crew had been diagnosed with a chronic condition, of which 60% had been hospitalized for this condition. Further, 18.2% of passengers had been diagnosed with a chronic condition, of which 53.3% had been hospitalized for this condition. A quarter of the crew (23.2%) had been affected by one communicable disease in the past and 20% of them had been hospitalized for this disease. Conversely, more than half the passengers (54.5%) had been affected by one communicable disease in the past, of which 17% had been hospitalized.

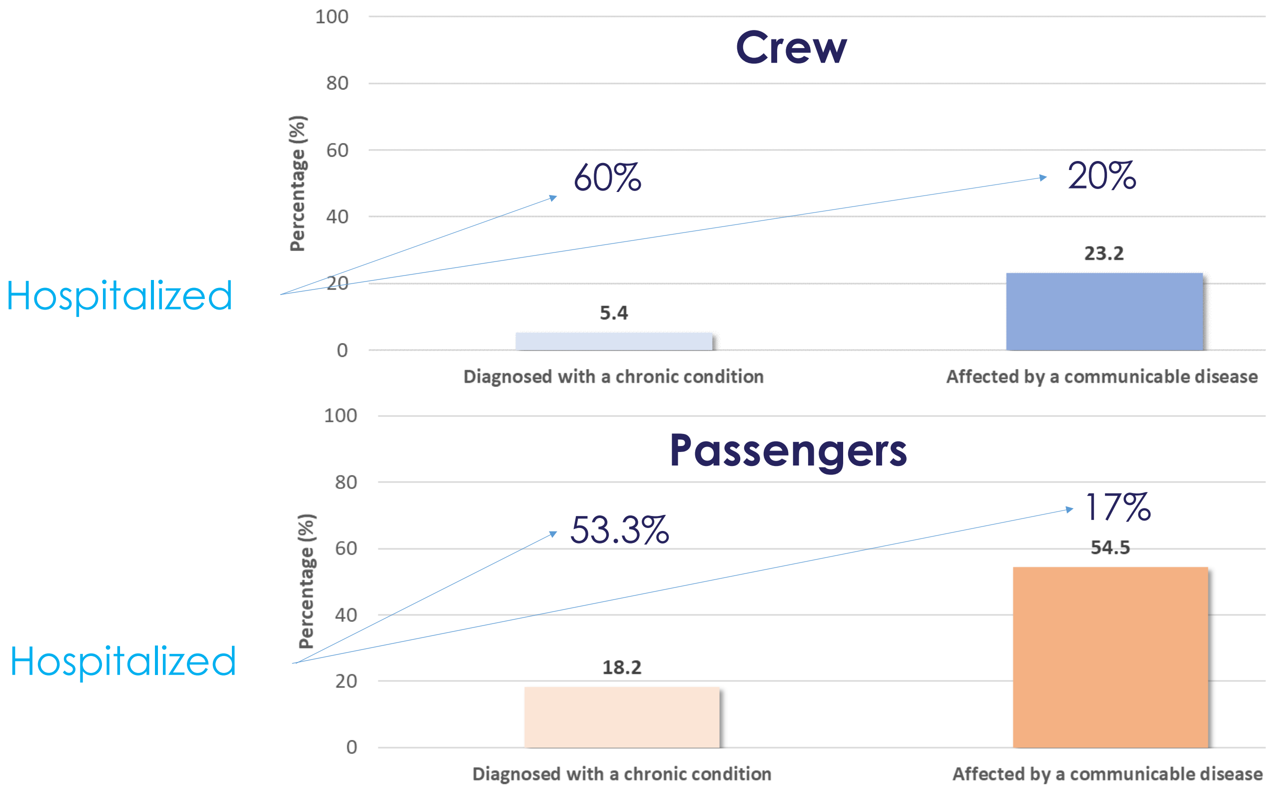

Figure 8: Medical history profile (crew and passengers).

The level of participants' agreement for some technological solutions on board a cruise ship to assist with the early detection of a communicable disease outbreak is presented in Figure 9 and Figure 10. Crew agreement percentages ranged very high, between 83.9% and 95.4%. More specifically, 83.9% of the crew agreed with outfitting the cabin's sink and toilet with virus sensors and 86.1% with outfitting the cabin with air quality sensors. Also, 95.4% of the crew agreed with cabin's and/or public spaces' surfaces being coated with antibacterial/antiviral materials and 94.6% with air purifiers being installed in the cabin and the air conditioning system. Passengers' agreement percentages ranged more widely, from 45.5% to 89.6%. More specifically, 45.5% of the passengers agreed with wearable devices (e.g., smartwatch) for health monitoring, 61.3% with outfitting the cabin's sink and toilet with virus sensors and 64% with cameras detecting passengers with fever. 89.6% of them also agreed with air purifiers in the cabin and the air conditioning system and 80.4% with outfitting the cabin with air quality sensors.

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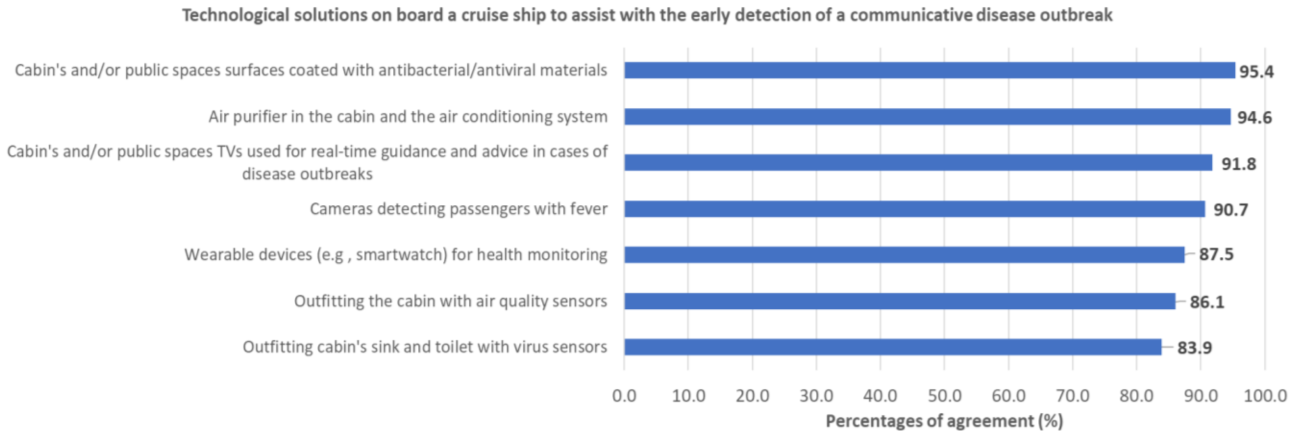

Figure 9: Willingness to accept technological solutions - Crew.

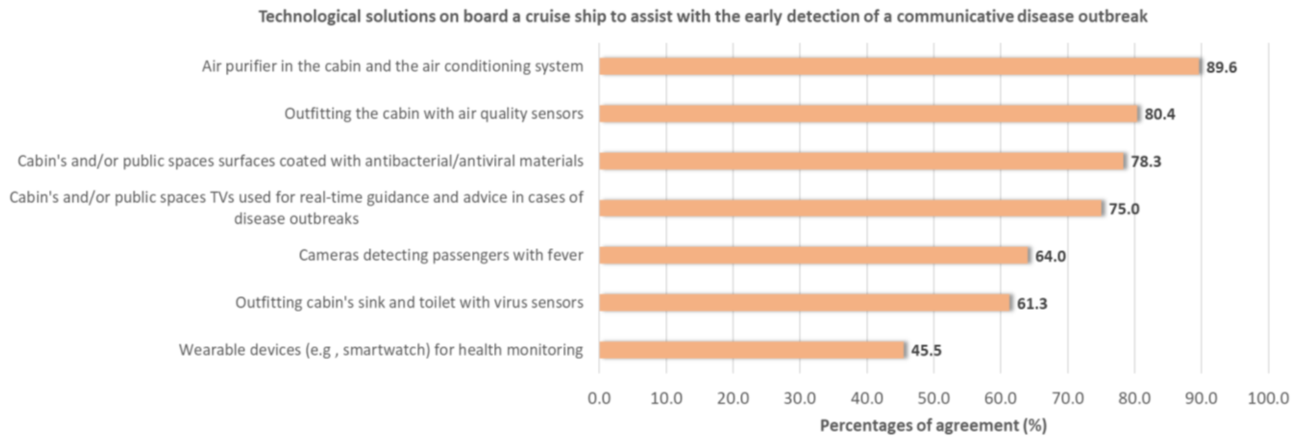

Figure 10: Willingness to accept technological solutions - Passengers.

From a combined analysis of Figure 9 and Figure 10, it appears that both passengers and crew record higher agreement levels for the following technological solutions (Table 18).

Table 18: Ranking of acceptance for the proposed technological solutions.

List of technological solutions	Crew (%)	Passengers (%)
Air purifier in the cabin and the air conditioning system	94.6	89.6
Cabin's and/or public spaces' surfaces coated with antibacterial/antiviral materials	95.4	78.3
Outfitting the cabin with air quality sensors	86.1	80.4
Cabin's and/or public spaces' TVs used for real-time guidance and advice in cases of disease outbreaks	91.8	75.0
Cameras detecting passengers with fever	90.7	64.0
Outfitting cabin's sink and toilet with virus sensors	83.9	61.3
Wearable devices (e.g., smartwatch) for health monitoring	87.5	45.5

Almost all crew members (N=274; 98%) agreed with at least one solution and 28 (10%) disagreed with at least one (Table 19). The main reason for agreeing was that they were in favour of use of any new technology (94.5%), followed by that the solution would safeguard / remove any health-related concerns during the cruise (91.2%).

The main reason for disagreeing was they were worried about their health data security (35%).

Most of the passengers (N=310; 92.3%) agreed with at least one solution and 107 (31.8%) disagreed with at least one. The main reason for agreeing was that they were in favour of use of any new technology (77.4%), followed by that the solution would safeguard / remove any health-related concerns during the cruise (76.5%).

The main reason for disagreeing was they did not want to be monitored (80.4%).

Table 19: Reasons for agreeing or disagreeing with the technological solutions on board a cruise ship to assist with the early detection of a communicative disease outbreak

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Agree / Strongly Agree
Crew	N (%)	N (%)	N (%)	N (%)	N (%)	%
If you "agree" or "strongly agree" with any of the solutions, why? (N=274; 98%)						
I am in favor of use of any new technology	2 (0.7)	2 (0.7)	11 (4.0)	110 (40.1)	149 (54.4)	**94.5**
It would safeguard / remove any health-related concerns during the cruise	1 (0.4)	3 (1.1)	20 (7.3)	159 (58.0)	91 (33.2)	**91.2**
If you "disagree" or "strongly disagree" with any of the solutions, why? (N=28; 10%)						
I am worried about my health data security	0 (0.0)	3 (10.7)	15 (53.6)	110 (40.1)	149 (54.4)	**35.7**
I am worried of being socially stigmatized in case of illness	0 (0.0)	5 (17.9)	17 (60.7)	5 (17.9)	1 (3.6)	**21.4**
I am worried about the effect it might have on my health	1 (3.6)	20 (71.4)	2 (7.1)	2 (7.1)	3 (10.7)	**17.9**
I am worried about feeling uncomfortable during (my work) on the cruise	0 (0.0)	20 (71.4)	1 (3.6)	2 (7.1)	5 (17.9)	**25.0**
I don't want to be monitored	1 (3.6)	19 (67.9)	2 (7.1)	0 (0.0)	6 (21.4)	**21.4**

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Agree / Strongly Agree
Passengers	N (%)	N (%)	N (%)	N (%)	N (%)	%
If you "agree" or "strongly agree" with any of the solutions, why? (N=310; 92.3%)						
I am in favor of use of any new technology	9 (2.9)	21 (6.8)	40 (12.9)	138 (44.5)	102 (32.9)	**77.4**
It would safeguard / remove any health-related concerns during the cruise	8 (2.6)	15 (4.8)	50 (16.1)	150 (48.4)	87 (28.1)	**76.5**
If you "disagree" or "strongly disagree" with any of the solutions, why? (N=107; 31.8%)						
I am worried about my health data security	3 (2.8)	12 (11.2)	15 (14)	48 (44.9)	29 (27.1)	**72.0**
I am worried of being socially stigmatized in case of illness	2 (1.9)	27 (25.2)	22 (20.6)	41 (38.3)	15 (14)	**52.3**
I am worried about the effect it might have on my health	8 (7.5)	21 (19.6)	41 (38.3)	27 (25.2)	10 (9.3)	**34.6**
I am worried about feeling uncomfortable during (my work) on the cruise	7 (6.5)	24 (22.4)	34 (31.8)	24 (22.4)	18 (16.8)	**39.3**
I don't want to be monitored	3 (2.8)	4 (3.7)	14 (13.1)	47 (43.9)	39 (36.4)	**80.4**

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4.4.3 Correlations

We tested a series of correlations and associations to investigate the impact of sociodemographic and participant medical history and cruise experience profile on their willingness to adopt technological solutions for the early detection of communicable diseases on board the cruise ship. The elements that produced a statistically significant impact on the factors tested are presented in this section, separately for crew and passengers.

Crew

Univariate analysis regarding crew members revealed that females crew members agreed in a significantly lower percentage with cameras detecting passengers with fever ($p<0.001$), wearable devices (e.g., smartwatch) for health monitoring ($p=0.028$), air purifier in the cabin and the air conditioning system ($p=0.010$) and cabin's and/or public spaces TVs used for real-time guidance and advice in cases of disease outbreaks ($p=0.002$) (Figure 11).

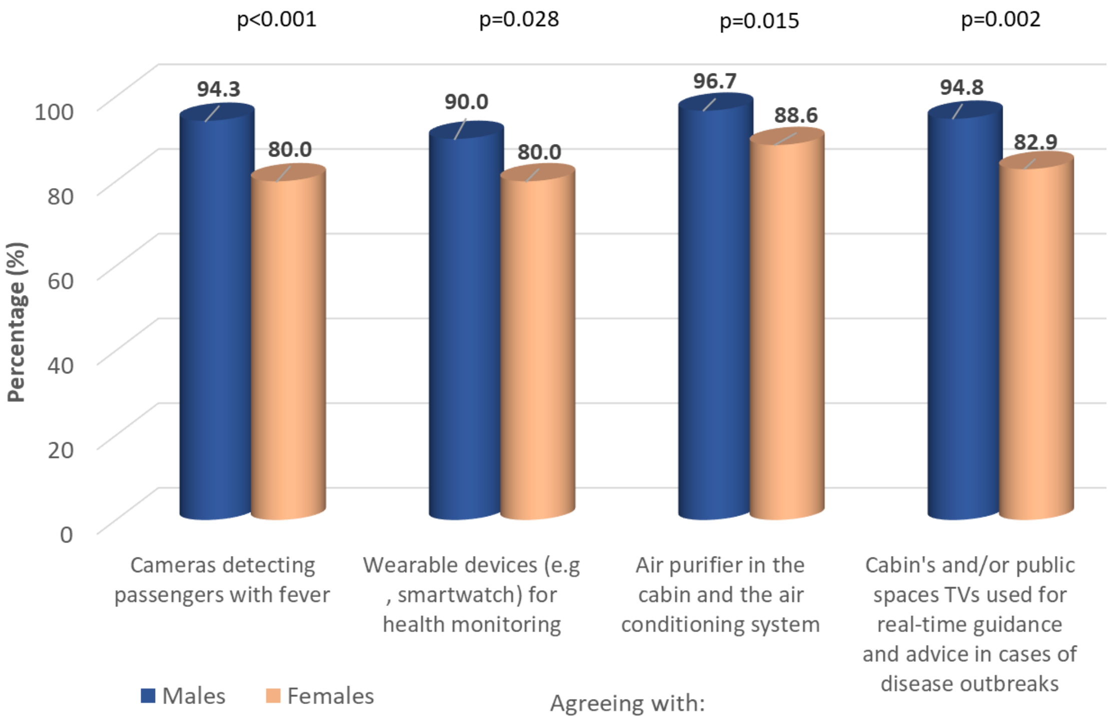

Figure 11: Difference between crew's acceptance of technological solutions relative to their gender.

Higher educational level for crew members was significantly associated with lower agreement with cameras detecting passengers with fever ($p=0.016$) and outfitting cabin's sink and toilet with virus sensors ($p=0,048$) (Figure 12).

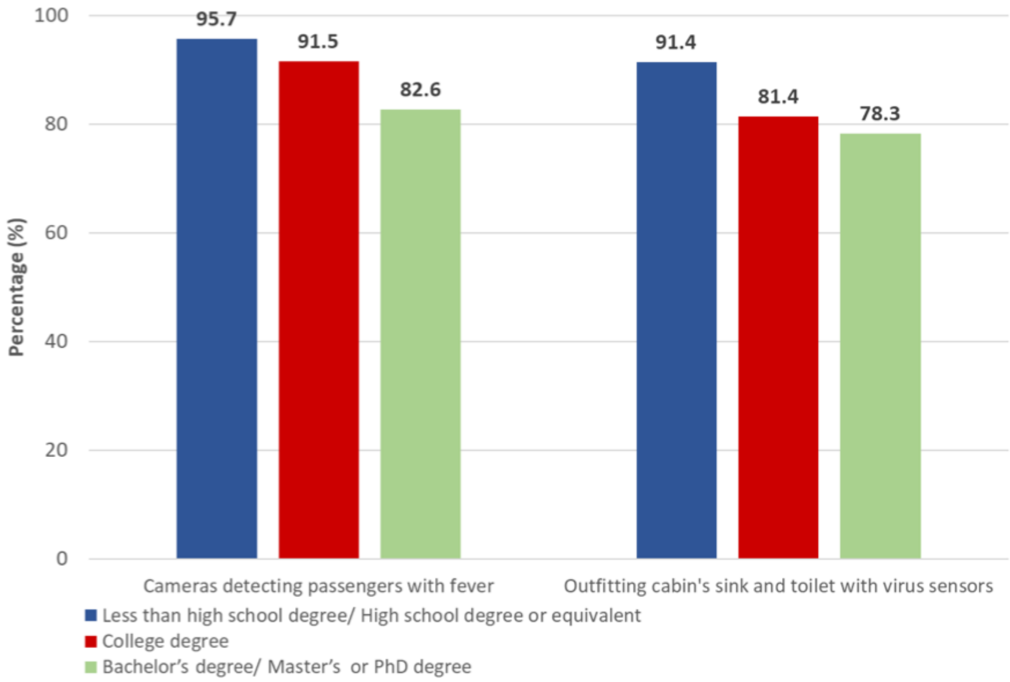

Figure 12: Crew's acceptance of technological solutions relative to their educational level.

Experience with cruise also impacted on crew's preferences, as crew members who were on their 1st cruise agreed in a significantly lower percentage with outfitting the cabin with air quality sensors (72.6% vs 87.2%; p=.008) and with outfitting the cabin's sink and toilet with virus sensors (75.8% vs 89%; p=.006).

On the other hand, age appears to have impacted positively to willingness to adopt technological solutions, as crew members who agreed with cameras detecting passengers with fever (p=0.001), outfitting the cabin's sink and toilet with virus sensors (p=0.001) and outfitting the cabin with air quality sensors (p=0.001) were significantly older (Table 20).

Table 20: Crew members' age by agreeing with Cameras detecting passengers with fever, Outfitting the cabin's sink and toilet with virus sensors and outfitting the cabin with air quality sensors.

Technological Solution / Willingness		Age		P Student's t-test
		Mean	SD	
Cameras detecting passengers with fever	Strongly disagree / Disagree / Neutral	30.29	9.90	0.001
	Agree / Strongly agree	38.26	11.54	
Outfitting cabin's sink and toilet with virus sensors	Strongly disagree / Disagree / Neutral	31.26	9.48	0.001
	Agree / Strongly agree	38.72	11.62	
Outfitting the cabin with air quality sensors	Strongly disagree / Disagree / Neutral	29.55	9.12	0.001
	Agree / Strongly agree	38.81	11.47	

Previous experience with a communicable disease also impacted on willingness to adopt new technological solutions, as crew members who had been affected by a communicable disease agreed in a significantly greater percentage with outfitting the cabin with air quality sensors (93.8% vs 83.7%; p=.039).

Multiple logistic regression analysis regarding crew members (Table 21) revealed that:

- Women had a 62% lower probability of agreeing with cameras detecting passengers with fever and a 54% lower probability of agreeing with wearable devices (e.g., smartwatch) for health monitoring compared to men.
- Women had a 73% lower probability of agreeing with air purifiers in the cabin and the air conditioning system and cabin's and/or public spaces TVs being used for real-time guidance and advice in cases of disease outbreaks, compared to men.
- Greater age was significantly associated with greater probability of agreeing with cameras detecting passengers with fever and outfitting the cabin with air quality sensors.
- Crew members with a college degree had a 60% lower probability of agreeing with outfitting the cabin's sink and toilet with virus sensors compared to crew members whose educational level was below high school degree/ High school degree or equivalent.
- Crew members with a bachelor's degree had a 75% lower probability of agreeing with cameras detecting passengers with fever and a 67% lower probability of agreeing with

outfitting the cabin's sink and toilet with virus sensors, compared to crew members whose educational level was below high school degree/ high school degree or equivalent.

- Crew members who worked on a cruise for the 1st time had a 62% lower probability of agreeing with outfitting the cabin's sink and toilet with virus sensors compared to crew members who had worked on a cruise for more than 1 time.

Table 21: Multiple logistic regression analysis results (crew).

Dependent variables	Independent variables	OR (95% CI)+	P
Cameras detecting passengers with fever	Gender (females vs males)	0.38 (0.16 – 0.91)	0.031
	Age	1.08 (1.03 – 1.13)	0.003
	Highest degree of education		
	College degree vs lower than high school degree/ High school degree or equivalent	0.54 (0.16 – 1.84)	0.325
	Bachelor's degree vs lower than high school degree/ High school degree or equivalent	0.25 (0.07 – 0.87)	0.030
Wearable devices (e.g., smartwatch) for health monitoring	Gender (females vs males)	0.44 (0.21 – 0.93)	0.032
Outfitting cabin's sink and toilet with virus sensors	**Highest degree of education**		
	College degree vs lower than high school degree/ High school degree or equivalent	0.40 (0.17 – 0.94)	0.037
	Bachelor's degree vs lower than high school degree/ High school degree or equivalent	0.33 (0.13 – 0.84)	0.021
	Is this your first time (been or have worked) on a cruise? (yes vs no)	0.38 (0.19 – 0.76)	0.006
Outfitting the cabin with air quality sensors	Age	1.09 (1.05 – 1.14)	<0.001
Air purifier in the cabin and the air conditioning system	Gender (females vs males)	0.27 (0.09 – 0.77)	0.014
Cabin's and/or public spaces TVs used for real-time guidance and advice in cases of disease outbreaks	Gender (females vs males)	0.27 (0.11 – 0.64)	0.003

Passengers

Univariate analysis regarding passengers revealed that female passengers agreed in a significant lower percentage with wearable devices (e.g., smartwatch) for health monitoring compared to men (41% vs 52.7%; p=0.036). Younger passenger age was associated with greater willingness to adopt some of the technological solutions, as passengers who agreed with cameras detecting passengers with fever (p=0.008), wearable devices (e.g., smartwatch) for health monitoring (p=0.012) and outfitting the cabin's sink and toilet with virus sensors (p=0.004) were significantly younger (Table 22).

Table 22: Passengers' agreement with cameras detecting passengers with fever, Outfitting cabin's sink and toilet with virus sensors and Wearable devices (e.g., smartwatch) for health monitoring, by age.

Technological Solution / Willingness		Age		P Student's t-test
		Mean	SD	
Cameras detecting passengers with fever	Strongly disagree / Disagree / Neutral	61.92	13.98	0.008
	Agree / Strongly agree	57.47	14.11	
Wearable devices (e.g, smartwatch) for health monitoring	Strongly disagree / Disagree / Neutral	60.84	13.64	0.012
	Agree / Strongly agree	56.95	14.63	
Outfitting cabin's sink and toilet with virus sensors	Strongly disagree / Disagree / Neutral	61.85	14.03	0.004
	Agree / Strongly agree	57.32	14.07	

Higher passenger educational level was significantly associated with lower agreement with outfitting cabin's sink and toilet with virus sensors (p=0.001), the cabin's and/or public spaces surfaces being coated with antibacterial/antiviral materials (p=0.022) and the cabin's and/or public spaces TVs being used for real-time guidance and advice in cases of disease outbreaks (p=0.010).

Employment status also revealed an impact on preferences for technological solutions amongst passengers, as those who were employed agreed in significantly higher percentages with wearable devices (e.g., smartwatch) for health monitoring (p=0.037), outfitting the cabin's sink and toilet with virus sensors (p=0.003), air purifier in the cabin and the air conditioning system (p=0.024) and cabin's and/or public spaces surfaces coated with antibacterial/antiviral materials (p=0.029) (Figure 13).

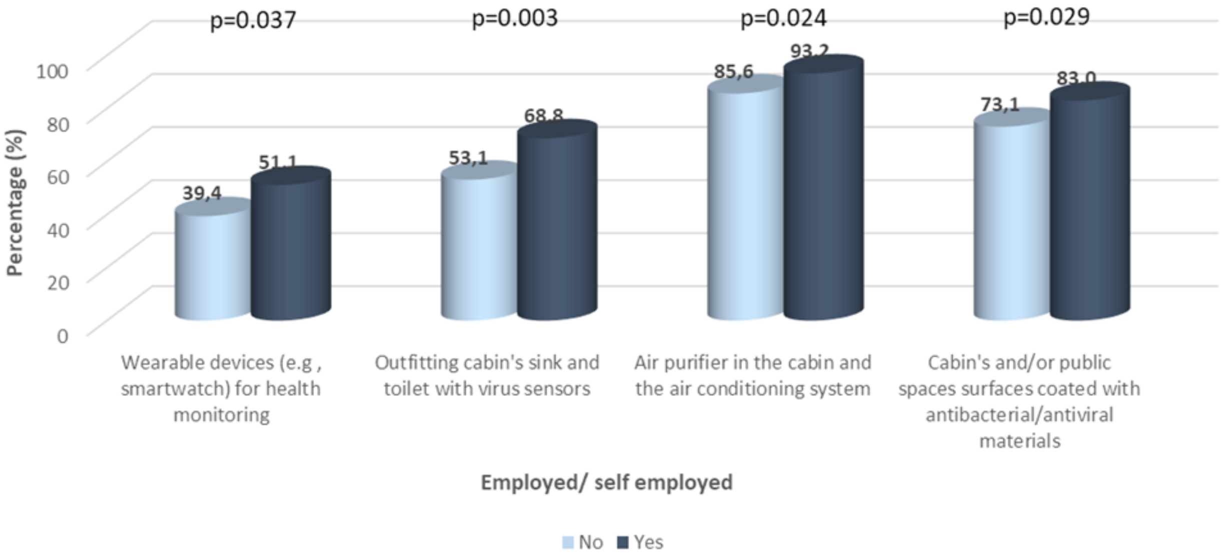

Figure 13: Percentages of agreeing with Wearable devices (e.g., smartwatch) for health monitoring, outfitting cabin's sink and toilet with virus sensors, air purifier in the cabin and the air conditioning system and cabin's and/or public spaces surfaces being coated with antibacterial/antiviral materials, by passenger employment status.

In line with findings for the crew, experience with cruise also impacted on crew's preferences, as passengers who were on their 1st cruise had significantly lower percentages of agreement with cabin's and/or public spaces surfaces being coated with antibacterial/antiviral materials (71.5% vs 82.2%; p=0.023). Further, passengers who had noticed any health or sanitation safety measures in place on board the ship, particularly for communicable diseases, had significantly lower percentages of agreement with cabin's and/or public spaces surfaces being coated with antibacterial/antiviral materials (75.5% vs 86.2%; p=0.037).

Previous experience with a communicable disease appears to impact on willingness to adopt new technological solutions, as passengers who had been affected by a communicable disease agreed in a significant higher percentage with cabin's and/or public spaces TVs being used for real-time guidance and advice in cases of disease outbreaks (79.2% vs 69.9%; p=0.050). Further, passengers who were afraid of contacting a communicable disease or infection on board the ship agreed with all solutions in significantly higher percentages than those who were not afraid (Figure *14*).

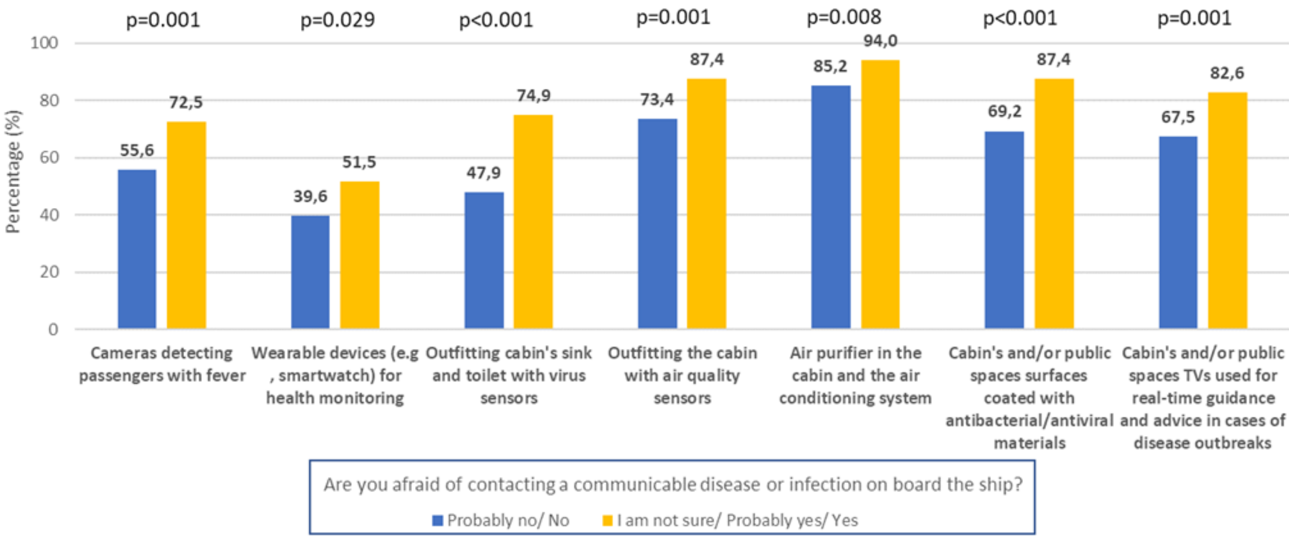

Figure 14: Percentages of agreeing with the technological solutions proposed associated with being afraid of contacting a communicable disease or infection on board the ship.

Presence of a chronic condition also impacted on preferences for technological solutions as passengers who been diagnosed with a chronic condition agreed in a significant lower percentage with cameras detecting passengers with fever (50.8% vs 66.9%; p=.026). Nonetheless, they agreed in a significant higher percentage with air purifiers in the cabin and the air conditioning system (96.7% vs 88%; p=.044).

Multiple logistic regression analysis regarding passengers (Table 23) revealed that:

- Women had a 38% lower probability of agreeing with wearable devices (e.g., smartwatch) for health monitoring compared to men.
- Greater age was significantly associated with lower probability of agreeing with cameras detecting passengers with fever, wearable devices (e.g., smartwatch) for health monitoring.
- Employed/self-employed passengers had a 2.78 times greater probability of agreeing with air purifiers in the cabin and the air conditioning system, a 2.13 times greater probability of agreeing with outfitting the cabin's sink and toilet with virus sensors and a 2.09 times greater probability of agreeing with cabin's and/or public spaces surfaces being coated with antibacterial/antiviral materials.
- Passengers with a college degree had a 73% lower probability of agreeing with outfitting cabin's sink and toilet with virus sensors and a 70% lower probability of agreeing with cabin's and/or public spaces TVs being used for real-time guidance and advice in cases of disease outbreaks, compared to passengers, whose educational level was below high school degree/ high school degree or equivalent.
- Passengers with a bachelor’s degree had a 75% lower probability of agreeing with outfitting cabin's sink and toilet with virus sensors and with cabin's and/or public spaces being surfaces coated with antibacterial/antiviral materials compared to passengers,

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whose educational level was below high school degree/ high school degree or equivalent. They also had a 71% lower probability of agreeing with cabin's and/or public spaces TVs being used for real-time guidance and advice in cases of disease outbreaks.

- Passengers with a master's or PhD degree had an 81% lower probability of agreeing with outfitting the cabin's sink and toilet with virus sensors, an 80% lower probability of agreeing with cabin's and/or public spaces TVs being used for real-time guidance and advice in cases of disease outbreaks and a 69% lower probability of agreeing with cabin's and/or public spaces surfaces being coated with antibacterial/antiviral materials, compared to passengers, whose educational level was below high school degree/ high school degree or equivalent.
- Passengers who were afraid of contacting a communicable disease or infection on board the ship had a 3.42 times greater probability of agreeing with outfitting the cabin's sink and toilet with virus sensors, a 3.28 times greater probability of agreeing with cabin's and/or public spaces surfaces being coated with antibacterial/antiviral materials, a 3.03 times greater probability of agreeing with air purifiers in the cabin and the air conditioning system, a 2.52 times greater probability of agreeing with outfitting the cabin with air quality sensors, a 2.23 times greater probability of agreeing with cabin's and/or public spaces TVs being used for real-time guidance and advice in cases of disease outbreaks, a 2.12 times greater probability of agreeing with cameras detecting passengers with fever, and a 1.68 times greater probability of agreeing with wearable devices (e.g., smartwatch) for health monitoring.
- Passengers who had been affected by a communicable disease had a 1.85 times greater probability of agreeing with cabin's and/or public spaces TVs being used for real-time guidance and advice in cases of disease outbreaks compared to passengers who had not been affected by such a disease.
- Passengers who had been diagnosed with a chronic disease had a 5.46 times greater probability of agreeing with air purifiers in the cabin and the air conditioning system.
- Passengers who were on their 1st cruise had a 47% lower probability of agreeing with Cabin's and/or public spaces surfaces being coated with antibacterial/antiviral materials compared to passengers who had been on a cruise in the past.

Table 23: Multiple logistic regression analysis results (passengers).

Dependent variables	Independent variables	OR (95% CI)⁺	P
Cameras detecting passengers with fever	Age	0.98 (0.96 — 0.99)	0.006
	Are you afraid of contacting a communicable disease or infection on board the ship? (yes vs no)	2.12 (1.34 — 3.36)	0.001
Wearable devices (e.g., smartwatch) for health monitoring	Age	0.98 (0.97 — 0.99)	0.017
	Are you afraid of contacting a communicable disease or infection on board the ship? (yes vs no)	1.68 (1.08 — 2.61)	0.022
	Gender (females vs males)	0.62 (0.39 — 0.97)	0.035
Outfitting cabin's sink and toilet with virus sensors	Are you afraid of contacting a communicable disease or infection on board the ship? (yes vs no)	3.42 (2.10 — 5.56)	0.000
	Employed/ self-employed (yes vs no)	2.13 (1.31 — 3.45)	0.002
	Highest degree of education		
	College degree vs lower than high school degree/ High school degree or equivalent	0.27 (0.11 — 0.64)	0.003
	Bachelor's degree vs lower than high school degree/ High school degree or equivalent	0.25 (0.11 — 0.57)	0.001
	Master's or PhD degree vs lower than high school degree/ High school degree or equivalent	0.19 (0.08 — 0.43)	<0.001
Outfitting the cabin with air quality sensors	Are you afraid of contacting a communicable disease or infection on board the ship? (yes vs no)	2.52 (1.43 — 4.46)	0.001
Air purifier in the cabin and the air conditioning system	Are you afraid of contacting a communicable disease or infection on board the ship? (yes vs no)	3.03 (1.38 — 6.63)	0.006
	Employed/ self-employed (yes vs no)	2.78 (1.30 — 5.91)	0.008

	Have you ever been diagnosed with a chronic condition? (yes vs no)	5.46 (1.24 — 23.99)	0.025
Cabin's and/or public spaces surfaces coated with antibacterial/antiviral materials	Are you afraid of contacting a communicable disease or infection on board the ship? (yes vs no)	3.28 (1.84 — 5.88)	<0.001
	Employed/ self-employed (yes vs no)	2.09 (1.18 — 3.69)	0.011
	Is this your first time (been or have worked) on a cruise? (yes vs no)	0.53 (0.30 — 0.94)	0.029
	Highest degree of education		
	College degree vs lower than high school degree/ High school degree or equivalent	0.36 (0.12 — 1.11)	0.076
	Bachelor's degree vs lower than high school degree/ High school degree or equivalent	0.25 (0.09 — 0.70)	0.008
	Master's or PhD degree vs lower than high school degree/ High school degree or equivalent	0.31 (0.11 — 0.91)	0.032
Cabin's and/or public spaces TVs used for real-time guidance and advice in cases of disease outbreaks	Are you afraid of contacting a communicable disease or infection on board the ship? (yes vs no)	2.23 (1.32 — 3.78)	0.003
	Highest degree of education		
	College degree vs lower than high school degree/ High school degree or equivalent	0.30 (0.11 — 0.84)	0.022
	Bachelor's degree vs lower than high school degree/ High school degree or equivalent	0.29 (0.11 — 0.74)	0.010
	Master's or PhD degree vs lower than high school degree/ High school degree or equivalent	0.20 (0.07 — 0.52)	0.001
	Have you ever been affected by one of these diseases? (yes vs no)	1.85 (1.10 — 3.11)	0.021

4.4.4 Reliability and validity of the questionnaire

Test-retest procedure was conducted in 25 participants and its results are presented in Table 24. Significant agreement was found in all questions (p<,001).

Table 24: Test-Retest results.

	Kappa	P
Are you familiar with the following communicable diseases?		
Covid-19	0.82	<0.001
Influenza	0.80	<0.001
Gastrointestinal diseases	0.83	<0.001
Legionella	0.78	<0.001
Have you ever been affected by one of these diseases?	0.90	<0.001
If yes, were you hospitalized?	0.83	<0.001
	ICC	**P**
Are you afraid of contacting a communicable disease or infection on board the ship?	0.81	<0.001
Do you agree with the use of the following technological solutions on board a cruise ship to assist with the early detection of a communicative disease outbreak?		
Cameras detecting passengers with fever	0.84	<0.001
Wearable devices (e.g , smartwatch) for health monitoring	0.92	<0.001
Outfitting cabin's sink and toilet with virus sensors	0.84	<0.001
Outfitting the cabin with air quality sensors	0.90	<0.001
Air purifier in the cabin and the air conditioning system	0.91	<0.001
Cabin's and/or public spaces surfaces coated with antibacterial/antiviral materials	0.89	<0.001
Cabin's and/or public spaces TVs used for real-time guidance and advice in cases of disease outbreaks	0.83	<0.001
If you "agree" or "strongly agree" with any of the solutions, why?		

I am in favor of use of any new technology	0.79	<0.001
It would safeguard / remove any health-related concerns during the cruise	0.78	<0.001
If you “disagree” or “strongly disagree” with any of the solutions, why?		
I am worried about my health data security	0.80	<0.001
I am worried of being socially stigmatized in case of illness	0.82	<0.001
I am worried about the effect it might have on my health	0.83	<0.001
I am worried about feeling uncomfortable during (my work) on the cruise	0.84	<0.001
I don’t want to be monitored		

To investigate the internal structure of the questionnaire, exploratory factor analysis (EFA) was conducted separately in crew and passengers. Regarding the technological solutions on board a cruise ship to assist with the early detection of a communicable disease outbreak it emerged one factor, accounting for 64% of the variance in the crew sample and 62.3% in the passengers’ sample. The results are presented in detail in Table 25.

For the crew, KMO value was .84 and Bartlett’s criterion was significant, p<.001, indicating adequacy of the sample for performing EFA. All loadings were above 0.4, thus no item needed to be removed from the analysis. Cronbach’s a was .90, higher than .70, thus, there was acceptable reliability.

For the passengers, KMO value was .86 and Bartlett’s criterion was significant, p<.001, indicating adequacy of the sample for performing EFA. All loadings were above 0.4, thus no item needed to be removed from the analysis. Cronbach’s a was .90, higher than .70, thus, there was acceptable reliability.

Items were averaged and the score of the factor was computed, that could range from 1 to 5, with higher values indicating greater agreement of having technological solutions on board for the early detection of an outbreak. Crew’s score ranged from 1 to 3.29, with mean value being 1.61 (SD=0.57) and passengers’ score ranged from 1 to 5, with mean value being 2.17 (SD=0.85).

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Table 25: Exploratory factor analysis results for the technological solutions, separately for crew and passenger samples (factor loadings).

List of technological solutions	Crew	Passengers
Cameras detecting passengers with fever	0.71	0.80
Wearable devices (e.g , smartwatch) for health monitoring	0.70	0.79
Outfitting cabin's sink and toilet with virus sensors	0.85	0.79
Outfitting the cabin with air quality sensors	0.80	0.85
Air purifier in the cabin and the air conditioning system	0.84	0.71
Cabin's and/or public spaces surfaces coated with antibacterial/antiviral materials	0.87	0.79
Cabin's and/or public spaces TVs used for real-time guidance and advice in cases of disease outbreaks	0.82	0.79
% Variance explained	**64.2**	**62.3**
Cronbach's a	**0.90**	**0.90**

For the part of the questionnaire concerning the reasons for agreeing of disagreeing with the presence of technological solutions on board for the early detection of an outbreak another EFA was conducted, but this time only in the passengers' sample (Table 26). The reason was the small sample size of the crew (N=28) that disagreed with these solutions, resulting into a small sample to conduct the EFA.

KMO value was .67 and Bartlett's criterion was significant, p<.001, indicating adequacy of the sample for performing EFA. All loadings were above 0.4, thus no item needed to be removed from the analysis. Two factors emerged from the analysis, one regarding the reasons for agreeing with these technological solutions (that included 2 items and explained 24.2% of the variance) and one for disagreeing with them (that included 5 items and explained 31.5% of the variance). Cronbach's a was higher than .70 for both factors, indicating acceptable reliability.

In the crew sample, the same structure as the one in the passengers' sample was applied and Cronbach's alpha coefficients were 0.76 for the factor of Reasons for Disagreeing and 0.70 for the factor of Reasons for Agreeing, indicating acceptable reliability.

Table 26: Exploratory factor analysis results for the part of the questionnaire concerning the reasons for agreeing of disagreeing with the presence of technological solutions on board for the early detection of an outbreak for the passengers' sample, after Varimax rotation.

	Reasons for agreeing	Reasons for disagreeing
I am in favour of use of any new technology		0.64
It would safeguard / remove any health-related concerns during the cruise		0.64
I am worried about my health data security	0.71	
I am worried of being socially stigmatized in case of illness	0.55	
I am worried about the effect it might have on my health	0.61	
I am worried about feeling uncomfortable during (my work) on the cruise	0.77	0.79
I don't want to be monitored	0.61	0.79
% Variance explained	**31.5**	**24.2**
Cronbach's a	**0.72**	**0.71**

4.4.5 Discussion

Our willingness to adopt technological solutions for the early detection of communicable diseases on board cruise ships surveys were conducted separately amongst passengers and crew to gauge an early understanding of the preparedness of both audiences to endorse the technological innovation that the HS4U project will be proposing as it evolves. Equally, our aim was to identify any critical barriers to adopting the HS4U value proposition and understand the parameters that may influence those barriers, such as sociodemographic characteristics and / or medical history and/or overall acceptance or use of technology.

Our surveys, conducted with the invaluable help of the Consortium's CELESTIAL cruise partners, most notably Mr. Pambos Skapoulis, Ms. Afroditi Stratakou and Mr. Panagiotis Megalooikonomou, together with all the office crew of the cruises, revealed a wide disparity amongst passengers and crew with regards to acceptance of possible technological solutions for the early detection of communicable diseases on board cruise ships. Though the crew appears more well prepared to accept and endorse use of such technologies, partly to ensure greater health safety in its place of work, passengers are more hesitant to sign up for such solutions, in their overwhelming majority because of monitoring and / or data security concerns. Greater age, employment, and fear of contacting communicable diseases on board the ship appear to positively impact on the acceptance levels for such solutions, whereas higher levels of education are related to lower acceptance and willingness to adopt levels.

Our survey adds to the literature on the need to monitor health vitals, particularly in closed spaces, to help detect earlier and manage more effectively communicable disease outbreaks, such as COVID-19. On board cruise ships, COVID-19 contact tracing has been evolving since the re-opening of cruises post pandemic breakout. Royal Caribbean International have invested in security camera enhancements that allow existing surveillance infrastructure to detect the places passengers have been -- and who they've been close to -- using facial recognition[133]. According to cruise-related information, advanced multi-camera search pinpoints and traces diagnosed individuals and identifies at-risk individuals using accurate face recognition, appearance similarity and proximity identification, for driving safety protocols while protecting the anonymity of affected individuals. In other words, if a passenger tests positive or becomes ill, their photo can be cross-referenced with camera footage to identify areas that person has visited while on board. From there, this technology can also determine the identities of anyone who was near ill passengers for an extended period to ask them to stay in their cabins until they can be tested. In addition to video surveillance and facial recognition, cruise lines are turning to other tracking methods for contact tracing, many of which are wearables. Years ago, Carnival Corp. introduced its OceanMedallion concept. The medallions, small metal discs, can be carried in a pocket, worn around the wrist, or put on a necklace, and they serve the same functions a keycard would (opening your cabin door, checking in and out when you go ashore, making onboard purchases). However, tapping into a system of wireless onboard checkpoints, the medallions also track passenger location, allowing crew to deliver food and drinks to just about anywhere you are on the ship and parents to monitor where their kids are, for example. Now, that same technology could help with contact tracing[133].

Further, the netTALK MARITIME Integrated Passenger and Crew Communications Experience has joined forces with the Tritan Software SeaCare platform to introduce new options to help stop the spread of COVID-19 and other potential outbreaks on cruise ships[134]. It all begins with a screening process before the voyage begins, which includes heart rate, breathing rate, body temperature, blood oxygen, a chat questionnaire and photo ID. If a person does become contagious, other passengers who have may have had significant contact with the infected can be traced and then resulting in them being tested and quarantined if needed. It is important to also know that the ID of the guest remains private and is only attached to the public once an infection is confirmed.

Tracing symptoms of communicable diseases to aid early detection and mitigate risk of further contagion has been extensively discussed and researched following the COVID-19 outbreak. A review by Katusiime et al.[135] investigated whether mHealth technologies impacted on the adoption of COVID-19 preventive measures, prevention knowledge acquisition and risk perception. Their review confirmed that utilization of mHealth interventions such as alert text messages, tracing apps and social media platforms was associated with adherence behaviour such as wearing masks, washing hands, and using sanitizers, maintaining social distance, and avoiding crowded places. The use of contact tracing was linked to low-risk perception as users considered themselves well informed about their status and less likely to pose transmission risks compared to non-users. Privacy and security issues, message personalization and frequency, technical issues and trust concerns were identified as technology adoption features that influence the use of mHealth technologies for promoting COVID-19 prevention.

Nonetheless, the success of contact tracing apps greatly depends on their large uptake within a population, in addition to strong public health enforcement. For contact tracing to work effectively, solutions such as tracing apps should be implemented systematically and this requires the secure collection, processing, storage, and discarding of contact tracing information of people in real time, without impinging on their privacy and rights[136]. In Germany, for example, a study by Blom et al.[137], estimated that 81% of the population aged 18 to 77 years possessed the devices and ability to install the official COVID-19 tracing app but only 35% were willing to install and use it. Potential spreaders showed high access to devices required to install the app (92%) and high ability to install the app (91%) but low willingness (31%) to correctly adopt the app, whereas for vulnerable groups, the main barrier was access (62%). Results are in line with those from the UK[138], where compliance on the part of the approximately 50% of participants who had the official NHS contact tracing app was high, yet there were still issues surrounding trust and understanding that hindered adoption. Another largescale, multi-country study to measure public support for the digital contact tracing of COVID-19 infections in France, Germany, Italy, the United Kingdom, and the United States[139], measured intentions to use a contact-tracing app across different installation regimes (voluntary installation vs automatic installation by mobile phone providers) and studied how these intentions vary across individuals and countries. The study found strong support for the app under both regimes, in all countries, across all subgroups of the population, and irrespective of regional-level COVID-19 mortality rates. Main factors that may hinder or facilitate uptake were concerns about cybersecurity and privacy, together with a lack of trust in the government. Results are broadly in line with those of a survey in Belgium[140], which found strong support for COVID-19 contact tracing apps. Amongst the 1,500 respondents, 48.70% (n=730) indicated that they intended to use a COVID-19 tracing app. The most important predictor was the perceived benefits of the app, followed by self-efficacy and perceived barriers. Perceived severity and perceived susceptibility were not related to app uptake intention. Moreover, cues to action (i.e., individuals' exposure to [digital] media content) were positively associated with app use intention. As the respondents' age increased, their perceived benefits and self-efficacy for app usage decreased.

Particularly amongst those with chronic health conditions, who have been disproportionately burdened by COVID-19 morbidity and mortality, COVID-19 contact tracing may be of extreme importance, yet its acceptability is still relatively low. Of the 10,760 respondents in a survey by Camacho-Rivera et al.[141] with self-reported diagnoses of cardiometabolic, respiratory, immune-related, and mental health conditions and overweight/obesity, 21.8% were extremely/very likely to use a mobile phone app or a website to track their COVID-19

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symptoms and receive recommendations. Additionally, 24.1% of respondents were extremely/very likely to use a mobile phone app to track their location and receive push notifications about whether they have been exposed to COVID-19. After adjusting for age, race/ethnicity, sex, socioeconomic status, and residence, adults with mental health conditions were the most likely to report being extremely/very or moderately likely to use each mobile health intervention compared to those without such conditions. Adults with respiratory-related chronic diseases were extremely/very (conditional odds ratio 1.16, 95% CI 1.00-1.35) and moderately likely (conditional odds ratio 1.23, 95% CI 1.04-1.45) to use a mobile phone app to track their location and receive push notifications about whether they have been exposed to COVID-19.

Further, COVID-19 catalysed wider acceptance of mobile health devices for monitoring key health indicators. In a large study across China[142], median score of willingness to use mHealth in the post-COVID-19 era was 70 points on a scale from 0 to 100. Multiple stepwise regression results showed that female gender (β=.03, 95% CI 1.04-2.35), openness personality trait (β=.05, 95% CI 0.53-0.96), higher household per capita monthly income (β=.03, 95% CI 0.77-2.24), and commercial and multiple insurance (β=.04, 95% CI 1.77-3.47) were factors associated with willingness to use mHealth devices. In addition, people with high scores of health literacy (β=.13, 95% CI 0.53-0.68), self-reported health rating (β=.22, 95% CI 0.24-0.27), social support (β=.08, 95% CI 0.40-0.61), family health (β=.03, 95% CI 0.03-0.16), neighbor relations (β=.12, 95% CI 2.09-2.63), and family social status (β=.07, 95% CI 1.19-1.69) were more likely to use mHealth devices.

Another survey by Seberger and Patil[143] explored how people in the United States perceived the possible routinization of pandemic tracking apps for public health surveillance in general. In the context of pandemic mitigation technology, including app-based tracking, people perceived a core trade-off between public health and personal privacy. People tended to rationalize this trade-off by invoking the concept of "the greater good". Nonetheless, potential negative consequences of pandemic mitigation technologies beyond the immediate needs of addressing the COVID-19 pandemic included the erosion of patient trust in health care systems and providers, grounded in concerns about privacy violations and overly broad surveillance.

Still, and as indicated in our results and confirmed throughout the literature, privacy concerns rank very high as a reason for low or no acceptance of use of such technological solutions[144]. In a survey on aircrafts, passengers were asked to declare their acceptance of the use of a Health Monitoring System, which could aid the cabin crew in early detecting critical health conditions[145]. Passengers were reluctant to share sensitive data and had concerns about how sensitive data is handled and whether it is stored carefully. However, the majority (over 70%, n≥ 11, effective sample size=16) agreed to have the most important vital signs such as heart rate, blood pressure, body temperature, and oxygen saturation measured. In a survey amongst airline passengers on their acceptance of the use of digital technologies in aircrafts, the facial recognition service, digital documentation, and AI Customer service were considered the least favourable among the 11 technologies offered by the airlines and assessed in the survey[146].

Sharing personal data such as testing regularity, infection, and immunization status on tracing apps amongst the public has been elsewhere tested for its acceptability by Howell and Abdelhamid[147]. Amongst a sample of adults in the general population, perceived vulnerability (β=0.688; P<.001), self-efficacy (β=0.292; P<.001), and an individual's prior infection with COVID-19 (β=0.194; P=.002) had statistically significant positive impacts on the intention to use mobile tracing apps. Privacy concerns (β=-0.360; P<.001), risk aversion (β=-0.150; P=.09), and a family member's prior infection with COVID-19 (β=-0.139; P=.02) had statistically significant negative influences on a person's intention to use mobile tracing apps.

Another study by Rising et al.[148] aimed to identify sociodemographic, health, and digital health behaviour correlates of US adults' willingness to share wearable data with health care providers and family or friends. Digital health behaviour measures included frequency of wearable device use, use of smartphones or tablets to help communicate with providers, use of social networking sites to share health information, and participation in a web-based health community. Most US adults reported willingness to share wearable data with providers (81.86%) and with family or friends (69.51%). Those who reported higher health self-efficacy (odds ratio [OR] 1.97, 95% CI 1.11-3.51), higher level of trust in providers as a source of health information (OR 1.98, 95% CI 1.12-3.49), and higher level of physical activity (OR 2.00, 95% CI 1.21-3.31) had greater odds of willingness to share data with providers. In addition, those with a higher frequency of wearable use (OR 2.15, 95% CI 1.35-3.43) and those who reported use of smartphones or tablets to help communicate with providers (OR 1.99, 95% CI 1.09-3.63) had greater odds of willingness to share data with providers. Only higher level of physical activity was associated with greater odds of willingness to share wearable data with family or friends (OR 1.70, 95% CI 1.02-2.84). Sociodemographic factors were not significantly associated with willingness to share wearable data. The findings of this study suggest that, among US adult wearable users, behaviour-related factors, rather than sociodemographic characteristics, are key drivers of willingness to share health information obtained from wearables with others. Moreover, behavioural correlates of willingness to share wearable data are unique to the type of recipient (i.e., providers vs family or friends).

Age is a factor that may also impact on willingness to adopt health monitoring technologies such as wearables. Drawing upon a national survey in US with 1481 older adults, Chandrasekaran et al.[149] examined the use of wearable healthcare devices and the key predictors of use viz. sociodemographic factors, health conditions, and technology self-efficacy. They also examined if the predictors were associated with the elders' willingness to share health data from wearable devices with healthcare providers. The survey revealed low level of wearable use (17.49%) and significant positive associations between technology self-efficacy, health conditions, and demographic factors (gender, race, education, and annual household income) and use of wearable devices. Men were less likely (OR = 0.62, 95% CI 0.36-1.04) and Asians were more likely (OR = 2.60, 95% CI 0.89-7.64) to use wearables, as did healthy adults (OR = 1.98, 95% CI 1.37-2.87). Those who electronically communicated with their doctors (OR = 1.86, 95% CI 1.16-2.97), and those who searched online for health information (OR = 1.79, 95% CI 1.03-3.10) were more likely to use wearables. Though 80.15% of wearable users were willing to share health data with providers, those with greater technology self-efficacy and favourable attitudes toward exercise were more willing.

As in our survey, literature confirms an association between experience of a communicable disease or fear of contacting such a disease with higher acceptance of technological solutions for its early detection. In a recent study by Park et al.[150], significant changes in users' privacy attitudes toward symptom tracking apps is reported as compared to the pre-COVID 19 era. Participants shared various reasons for both increased acceptability (disease uncertainty, public good) and decreased acceptability (reduced utility due to changed lifestyle) during COVID-19.

In any case, the situation is different when wearables are used to signal emergencies. The SafePASS project, which has been working on technology solutions to provide passengers with dynamic, real-time information they can understand and follow to aid their evacuation from cruise ships in event of an emergency, ran a willingness to adopt survey amongst cruise ship passengers. The latter responded positively to the use of a Passenger Mobile Application for directions (suggesting a willingness to use smartphone technologies as support in emergencies), while they responded neutrally to wearable technologies (such as Smart Lifejacket, Smart Wristband). Crew responded positively to the use of smartphones and wearable technologies in emergency situations. The survey confirmed high acceptability of smartphone-based technologies for use by crew in emergency situations[151].

Further, our findings that crew members may be more willing and prepared to adopt technological solutions to detect communicable diseases on board cruise ships are in line with broader literature on wearables in the workplace, which ensure greater safety at work. A study of Jacobs et al.[152] determined factors that predict employee acceptance of wearables. An online survey of 1273 employed adults asked about demographics, job and organizational characteristics, experience with and beliefs about wearables, and willingness to use wearables. Use cases focused on workplace safety elicited the highest acceptance. An employee's performance expectancy and their organizational safety climate were common predictors of acceptance across use cases. Positive past experiences coincided with involving employees in choosing the device and adequately informing them about data use. The study underlined that organizations intending to implement wearable technology should (a) focus its use on improving workplace safety, (b) advance a positive safety climate, (c) ensure sufficient evidence to support employees' beliefs that the wearable will meet its objective, and (d) involve and inform employees in the process of selecting and implementing wearable technology.

Finally, the literature confirms a gap on availability and assessment of acceptance of use of tracking devices or sensors within cruise ship cabins. Given the high sensitivity of health monitoring within cabins, interventions to assess and report on willingness to monitor health vitals using sensors appears to be underdeveloped. This is an area, where HS4U with its

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robot cabin, may substantially add to both current understanding and state of the art and the relevant literature.

4.5 Conclusion

From the analysis above it becomes evident that introducing technological solutions to aid with the early detection of communicable diseases such as COVID-19 and norovirus on board cruise ships may be vastly challenging, particularly as regards the actual endorsement and adoption of such tools by passengers and crew. And even if any crew apprehension could be effectively addressed through appropriate workplace training, passenger acceptance may have to be more extensively cultivated through targeted awareness and education interventions that have the potential to assuage any concerns around use of technologies and monitoring of personal health data.

To this end, it is imperative that - very early on in the HS4U project - processes are developed that concretely describe how health monitoring data would be reviewed and stored for early detection of communicable diseases purposes and how, ultimately, privacy and data safety would be safeguarded once the project is fully developed.

It is, then, necessary to work with our cruise partners to customize this information into awareness and education materials that target cruise passengers and help explain the process, its expected outcomes, and its importance in safeguarding public health, and, thus, create an environment of trust during the cruise. Highlighting the role of the ship's doctor in accessing and translating those data at the individual level may also be critical in establishing trust and willingness to adopt, as, according to the literature, sharing health information with a health professional is much better accepted compared to being unaware of who and why reads personal health monitoring data acquired through technological tools such as sensors and wearables.

Our findings are based on a quantitative analysis to identify levels of willingness to accept specific technological solutions as well as any barriers to this acceptance and assess extent of impact of various profile factors on both. As a next step, it could be useful to probe in greater depth through a qualitative survey (focus group) into details of proposed technological solutions relative to the process that will be applied for data management to assess whether acceptance levels can be enhanced as well as identify the most appropriate and effective way to organize and implement an awareness and education campaign amongst cruise passengers.

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5. Section 4. Workshop with external stakeholders

5.1 Aims and outcomes of the workshop.

The methodology and key findings of the work performed in Task 2.1 were presented to a Workshop with external stakeholders. It is described in the Grant Agreement as the 2nd Workshop with external partners and it was conducted via the Zoom platform. The main goal of this meeting was to review and discuss the whole process described in the above sections and ultimately to validate the key findings of the stated preference surveys.

The list of participants, the agenda and the minutes of this workshop are presented in detail in Annex 4. The main outcome of the meeting was that the systematic literature review was considered complete, reliable, and well presented, and that the key findings of the survey were valid. The reviewer also considered the survey and its findings very useful both to the progress of the HS4U project and to inform the current body of evidence and aid further research on the subject matter. To this end, the member of the External Advisory Board urged the members of the consortium to publish the findings of D2.1 in scientific journals as this would add to the present literature.

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ANNEXES

ANNEX 1 – Minutes of 1st Workshop with internal partners

SUMMARY

This document summarizes the discussion during the internal workshop that took place on the 9th of January 2023, among the partners involved in Task 2.1 of WP2. It is described in the Grant Agreement as the 1st Workshop with internal partners and it was conducted via the Zoom platform. The main goal of this meeting was to validate the practice gap identified by Systematic Literature Review in screening and early detection of the most prevalent communicable diseases during a cruise, and to present to the cruise partners the technological solutions that may be considered to address this gap.

LIST OF PARTICIPANTS

	NAME	COMPANY
1	Christina Golna	HPI
2	Ioannis Markakis	HPI
3	Pavlos Golnas	HPI
4	Panagiotis Evangelou	NTUA
5	Paolo Franceschini	VAR
6	Bérengère Lebental	UNI EIFFEL
7	Kaitlyn West	COLUMBIA
8	Anna Kontini	AETHON
9	Pambos Skapoullis	CELESTYAL
10	Miguel Pacheco	UNPARALLEL
11	Andreas M.Papachristoforou	CELESTYAL
12	Bruno Almeida	UNPARALLEL

AGENDA

EVENT	**1st Workshop with internal partners**
DATE	09.01.2023
PLACE	Online

HS4U 1st Workshop with internal partners			
Schedule	Agenda		
12:00 - 12:05	WP2	Welcome – Adoption of the agenda – Objectives of the workshop	HPI
12:05 - 12:20	WP2	Systematic Literature Review, Overview and results	HPI
12:20 - 13:00	WP2	Discussion on adoption of outcomes of SLR - any additional measures/practices currently implemented on board cruise ships	All Partners
13:00 - 13:15	WP2	Presentation of potential technological solutions to address practice gap	UNI EIFFEL
13:15 - 13:30	WP2	Presentation of toolbox to elicit preferences for and willingness to adopt any of the technological solutions	VAR
13:30 - 14:45	WP2	Discussion on technological solutions that the cruise partners would be willing to adopt on cruise ships	All Partners
13:30 - 14:45	WP2	Discussion on whether additional technological solutions are expected / desired to be implemented.	All Partners
13:30 - 14:45	WP2	Discussion on the areas of the ship where these technological solutions could be deployed.	All Partners
14:45 - 15:00	Wrap up – Next steps		

MINUTES

Several days before the workshop a dedicated folder was created on Onedrive storing platform, which contained the Workshop's agenda, a draft version of Deliverable 2.1 ("Mappings of existing framework conditions, challenges, system failures and gap analysis"), a draft version of Deliverable 3.1 ("Requirements for sensing and actuation systems") and several pdf files of the Mural guidelines. The partners who participated at the Workshop were urged to read those documents prior to the meeting, to increase the workshop's productivity.

At the beginning of the workshop, Christina Golna (HPI) welcomed the participants, presented the meeting's agenda and the workshop's goals and objectives. Once the agenda was adopted by all participants, she presented the interim deliverable for D 2.1 i.e., the systematic literature review (SLR) of the most prevalent communicable diseases on board cruise ships, and the mapping of EU and international guidelines on prevention, screening, diagnosis, and containment of these diseases onboard cruise ships. The SLR confirmed that the most prevalent and important diseases on board cruise ships (when viewed in combination with their public health impact and burden) are COVID-19, influenza, gastrointestinal infections, and legionnaire's disease. With regards to the guidelines and recommendations aimed at addressing these, the SLR confirmed that prevention and risk mitigation are exhaustively addressed in the current literature. Diagnosis is also adequately detailed, referring to availability and accessibility of diagnostic means and resources. Conversely, despite screening and early identification being cardinal in prompt diagnosis and effective risk mitigation, both of which are extensively presented as goals of public health interventions on board cruise ships, there appears to be limited reference to tools and methods to perform large scale screening and early identification amongst passengers and crew on board cruise ship. Such interventions would probably necessitate use of wearables or other biosensing devices that are to-date not included in the relevant literature.

Subsequently, she presented SLR results on current recommendations and guidelines specifically for screening and early detection in the four (i.e., COVID-19, influenza, gastrointestinal infections, legionnaire's disease) most common communicable diseases on cruise ships (in tabular format). Participants were then invited to validate these findings as well as highlight any additional measures /practices implemented on their ships with regards to screening and early detection of these conditions. Kaitlyn West (Columbia) mentioned that some cruise companies apply pre-joining vaccination requirements for COVID-19 to crew and passengers. It was explained that this recommendation was included in the prevention section of interventions detailed in the SLR. Moreover, Andreas Papachristoforou (CELESTYAL) commented on the need to maintain records and data statistics if such a health problem arises on board. In that way the medical personnel of the ship would be trained in identifying the symptoms for each one of these diseases. The necessity of this requirement was completely agreed upon – it was clarified that this requirement is included in the surveillance requirements in the SLR. Pambos Skapoulis (CELESTYAL) noticed that in CELESTYAL cruise ships there is a recommendation to encourage the passengers to visit

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the doctor of the ship in case they have one or more symptoms of these communicable diseases. In such cases the doctor's visit should be free of charge, if to encourage passenger uptake of this recommendation. Bérengère Lebental (UNI EIFFEL) enquired after specific legal requirements in screening and early detection and participants confirmed that the legal framework to be considered is as mentioned in the recommendations in the SLR. Pambos Skapoulis added that the screening procedures are detailed by the operations department of each cruise company and are applicable to all ships in the fleet of that company. At the end of this first part of the workshop, all participants agreed with the results of the SLR, validated its findings and confirmed the practice gap and, therefore, the target of the project.

The second part of the Workshop started with Bérengère Lebental (UNI EIFFEL) presenting the work already completed in T3.1. She initially presented the main goals of sensors and actuators and emphasized the early detection of the diseases identified and their symptoms (particularly fever). Another important goal to be pursued would be the localization (tracking) and confinement of contaminated people. Several scenarios were analyzed and considered, including passenger tracking (use of wearable devices or fixed sensors in public places), detection of specific diseases (sensor outfitting sinks and toilets), prevention of disease colonization (furniture and textile outfitted with antibacterial coatings), prevention of disease transmission through air (room air and HVAC purification, air quality monitoring) and information sharing (apps and screens for sharing information). She addressed five (5) questions to cruise partners:

- What is the budget allocation for each ship or per passenger for health-related actions?
- How to ensure acceptability by passengers and crews of HS4U solutions (collection of personal data through smart wearables, cabin monitoring etc.)?
- What is the most critical disease to detect?
- Which public spaces are the most critical to monitor?
- Are there any other technological solutions which should be included in HS4U?

As per the agenda, Paolo Franceschini introduced the "mural" toolbox which tries to collect needs, requirements, and jobs to be done regarding the project at hand to facilitate consensus building. It is based on the principle of the Customer's pains and gains, where the customer can be either the cruise manager or the passengers. This process will help the consortium decide which is the most beneficial solution to implement. Due to time restrictions, participants decided it would be best to share documents related to the mural with the cruise partners via email. They will then discuss it internally with their appropriate department and fill in the requested information. These data will be presented in a future workshop.

A discussion followed on the enquiries submitted by Bérengère Lebental. The topic of the most critical disease was discussed first. Pambos Skapoulis stated that currently the main disease of concern is COVID. Even though we don't know exactly how the pandemic will evolve over the next years, the main concern of the cruise ship companies will probably be the management of COVID patients on board.

At this point, Kaitlyn West added that the project should also focus on norovirus, due to its high impact both on operations (how it is managed on board) and on ship companies' reputation, as it affects the media due to bad publicity and consequently their bookings much more severely than COVID. Pambos Skapoulis emphasized the persistent challenge of norovirus for ship companies; yet, he stated that the crew is familiar with the handling of norovirus cases, unlike COVID, as the disease is still more unpredictable. Both Kaitlyn West and Pambos Skapoulis agreed that the project should also investigate the early detection of norovirus.

The discussion then turned to the budget per passenger, which the cruise companies would consider investing to implement additional screening-related interventions. Kaitlyn West underlined the difficulty in defining such a budget and suggested a cost effectiveness analysis, to compare the proposed benefit of an intervention in a potential outbreak versus its cost. Bérengère Lebental said that the range of a potential solution’s cost would be very wide, and she asked if the cruise partners could give an estimation of magnitude of acceptability. Pambos Skapoulis stated that indeed it is matter of budget and priorities, as it relies on the policy of each company whether they would be willing to pay more and be on the safe side or not. Bérengère Lebental insisted that the technical partners would need guidance from the cruise companies of what the current budget is for prevention and monitoring of these communicable diseases. Anna Kontini (AETHON) emphasized this requirement, by noting the requirement of WP3 for a cost-benefit analysis of the solutions which are going to be developed. A proposed solution would be more concrete if they know the current budget allocation and how this will be configured when using the new technological solutions. Pambos Skapoulis highlighted the need to identify and report the symptoms as early as possible. He also stated that we should combine technology with other procedures and guidelines of the cruise ship, i.e., the encouragement to visit the ship’s doctor once the symptoms have been verified e.g., from a biosensing device.

Bérengère Lebental asked if the operations’ department of the two cruise companies could share with the consortium the process they apply for screening for norovirus and COVID on board the ship. Paolo Franceschini agreed on the mapping of all the procedures that the two companies follow for early detection of the two diseases, so the proposed solution could be more beneficial.

Moving forward, Christina Golna asked participants to focus on the questionnaire to be developed and addressed to the crew and passengers about their willingness to accept the proposed technological solutions. She highlighted the need to a) select and detail, and b) rank the technological solutions to be offered from the consortium’s point of view. Bérengère Lebental answered that the highest-ranking technological solution that could be investigated with passengers and crew would be a smart wearable that would report on the health-related parameters of the wearer to the medical personnel of the ship. Secondly, a sink or toilet that would be outfitted with biosensors for norovirus and COVID. Thirdly, an application to be

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installed on passenger mobile phones that would support symptom tracking and urge for a visit to the ship's doctor, as required. Fourthly, applications to monitor air-quality in cabins. Fifth, coating of cabin furniture with anti-bacterial material. At this point, Anna Kontini asked if we should further break down monitoring options per symptom. In response, it was suggested that the challenge with acceptability would probably lie with the monitoring as a process not with the specific symptom that would be monitored., therefore it may be too detailed and potential not very beneficial to inquire after acceptability of monitoring of specific symptoms.

The last technological solution, which Bérengère Lebental asked to be added to the questionnaire was the installation of large screens with information and recommendations of what the passengers should do in case they have symptoms of a specific disease. Paolo Franceschini urged the participants to focus the questionnaire more to the problem that they are trying to solve, than in the acceptance of the technological solution. Pambos Skapoulis' concern related to how practical it would be to have a 100% acceptance of each proposed technological solution. From his point of view, the consortium should take into consideration a 10% - 20% of passengers who are expected to refuse to use any of these solutions. Anna Kontini suggested offering these passengers the alternative to visit the doctor daily. Pambos Skapoulis commented that the mandatory use of a bracelet or any other technology would inevitably result in losing some passengers from cruises. Bérengère Lebental stated that based on her discussions in other WPs there is no need for a 100% coverage of the passengers, however it is still undefined what this percentage should be and what types of passengers it should cover.

John Markakis (HPI) asked the cruise participants whether there is another technological solution that they would expect the consortium to consider, and it not included in the those presented and discussed at the workshop. Pambos Skapoulis confirmed that all these technological solutions can be very useful, but it is also a question of cost and investment for the cruise industry. Bérengère Lebental enquired after the department responsible for defining such a budget within the cruise organization. Pambos Skapoulis confirmed this is the operations' department and offered to facilitate the consortium getting in touch with them.

John Markakis (HPI) wrapped up the meeting, listing next steps and timelines and thanked all participants for their contribution to the Workshop.

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COMMENTS, ACTION LIST AND AGREEMENT

Critical action points that were discussed during the workshop are presented in a tabular form below.

	CONTENT	PARTNER(S) IN CHARGE	DEADLINE	STATUS
1	HPI will prepare the Minutes of the workshop and validate them with the participants of the meeting. Next, they will be shared with the rest of the consortium.	HPI	13/01/2023	COMPLETED
2	HPI will prepare the Workshop with external advisors.	HPI	28/02/2023	OPEN
3	HPI will prepare the questionnaire for the crew and passengers about their willingness to adopt the technological solutions proposed by HS4U and send it to the partners for validation.	HPI	31/03/2023	OPEN
4	VARIANCE ASCOLA will organize the Mural so the other partners can download it and use it.	VARIANCE ASCOLA	13/01/2023	COMPLETED

PRESENTATIONS DURING THE WORKSHOP

PRESENTATION “MAPPINGS OF EXISTING FRAMEWORK CONDITIONS, CHALLENGES, SYSTEM FAILURES AND GAP ANALYSIS”

Presented by Christina Golna (HPI)

PRESENTATION “MAIN GOALS OF SENSORS AND ACTUATORS”

Presented by Bérengère Lebental (Eiffel University)

PRESENTATION “MURAL – HS4U PAINS AND GAINS”

Presented by Paolo Franceschini (Variance Ascola)

PRESENTATION "MAPPINGS OF EXISTING FRAMEWORK CONDITIONS, CHALLENGES, SYSTEM FAILURES AND GAP ANALYSIS"

Presented by Christina Golna (HPI)

Mappings of existing framework conditions, challenges, system failures and gap analysis

WP2: HS4U Project Requirements' Elicitation and Architecture

Christina Golna, LLB, LLM, MSc, The Health Policy Institute

DATE: 09 January 2023

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Research Questions

- What are the most prevalent communicable diseases on board cruise ships?
- How are these managed **across the public heath continuum** (prevention, screening and diagnosis and risk mitigation) and **the journey timeline** (before embarkation, on board the ship, prior or during disembarkation)?
- Is there any gap in their management according to current guidelines and recommendations versus what may be considered state of the art?
- What are the state-of-the-art solutions that can address this gap?
- How willing are passengers and crew to endorse / implement/follow these solutions? What are their preferences?

Expected deliverable

Specific list of state-of-the-art solutions to elevate required public health readiness on board cruise ships, for which there is a stated passenger and crew preference

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Where are we now?

SLR - Report 2.1.1

- ✔ What are the most prevalent communicable diseases on board cruise ships?
- ✔ How are these managed **across the public heath continuum** (prevention, screening and diagnosis and risk mitigation) and **the journey timeline** (before embarkation, on board the ship, prior or during disembarkation)?
- ✔ Is there any gap in their management according to current guidelines and recommendations versus what may be considered state of the art?
- What are the state-of-the-art solutions that can address this gap?
- How willing are passengers and crew to endorse / implement/follow these solutions? What are their preferences?

Expected deliverable

Specific list of state-of-the-art solutions to elevate required public health readiness on board cruise ships, for which there is a stated passenger and crew preference

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SLR Methodology

- Our search approach included defining several core keywords that were used to form the main search algorithm and screen resulting articles. These were the following:

cruise ship	health threat	disease	communicable disease	outbreak
prevalence	epidemiology	indicator	index	measure
management	mitigation	mitigation plan	emergency treatment	treatment

- The final form of the main algorithm used in the official data sources was:

(health threat** or **communicable disease** or **disease** or **epidemic** or **outbreak)** and **(cruise ship** or **cruise** or **cruise ship** or **ship** or **on dock)** and **(prevalence** or **frequency** or **indicator** or **index** or **measure** or **rate).

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Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Studies from 2015 to-date (8 years)	Studies prior to 2015
Observational studies and randomized trials, reviews, systematic reviews, and meta-analyses	Purely laboratory work-experiments (not tested in the field)
Human objects	Animals
English or Greek	Other languages
Available full text	Not available full text

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SLR PRISMA

Identification

- Articles from Databases (n=9,881)*
- Online documents (n=52)

- Duplicate articles removed before screening (n=8,435)
- Duplicate online documents removed before screening (n=3)
- Articles removed upon cross-checking inclusion/exclusion criteria (n=25)

Screening

- Articles screened by title (n=1,421)
- Online documents (n=49)

- Articles excluded (n=528)
- Online documents excluded (n=26)

- Articles screened by abstract (n=893)

- Articles excluded (n=779)

- Articles screened by full text (n=114)

- Articles excluded (n=19)

Included

- Articles (n=95)
- Online documents (n=23)

* Articles break down: 1352 Pubmed, 138 Scopus, 91 Cochrane Library, 8300 Google Scholar

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Results

- Communicable diseases with highest frequency and public health burden on cruise ships:
  - COVID-19 (34/95)
  - Influenza (9/95)
  - Gastrointestinal infections (9/95)
  - Legionella (4/95)

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Results

- For each of the 4 conditions we have mapped (as available):
  - Prevalence / incidence
  - Positive tests/population tested
  - Asymptomatic individuals/total population
  - Attack rate
  - Basic reproduction number
  - Risk Ratio
  - Odds Ration (probability of outbreak)
  - % Of cases on board cruise ships/total cases
  - % Of deaths on board cruise ships/total deaths
  - Hospitalization rate
  - % of deaths/hospitalizations
  - % deaths/positive tests
  - Mortality rate
  - Case Fatality Ratio

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Results

We then mapped all available international and EU guidelines on their management on a public health continuum

01

Prevention

How to prevent incidence

02

Screening and Early Detection

How to identify early

03

Risk Containment/mitigation

How to stop spreading

04

Other

Surveillance
Reporting

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Results

For each pillar of the public health continuum, we mapped guidelines according to the phase of the travel to which they referred:

Before or upon embarkation

On board the ship (during travel)

Prior to or upon disembarkation

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Results(illustrative): Tables (29 pages)

Guidelines/recommendations (By whom, Link)	Prevention	Screening and diagnosis	Risk containment	Other
By: EU SHIPSAN ACT JOINT ACTION (20122103) **Title:** *European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. Second edition. (2016)* [91] **And** **EU SHIP SANITATIN TRAINING NETWORK - SHIPSAN TRAINET PROJECT (2007206)** **Title:** *European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. European Commission Directorate General for health and consumers (2011)* [92]	• Include provisions for Legionella control in any WSP established on board the ship • Maintain specific temperature in water system • Run all taps and showers in cabins for several minutes at least once a week if they are unoccupied and always prior to occupation • Clean to remove scale, salt, sediments, sludge, dirt and debris from the water tanks and distribution system • Apply disinfection to reduce the number of microorganisms in the water to levels that cannot cause harm • Establish a schedule for regular cleaning and disinfection of all water system components • Drain water before any repairs to pipes etc. • Wear PPE before cleaning • Perform regular sampling of water at least every 6 months	Confirm disease with microbiological diagnosis	• Close any facility considered source of infection • Collect pre-disinfection samples • Perform preliminary risk assessment of the ship's water systems • Review maintenance and monitoring regimes and records • Perform post-disinfection sampling from points representing different loops of the water systems **After disembarkation** Initiate disinfection, repairs, change of filter media and others to avoid the recurrence of an outbreak in the next voyage	

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Results(illustrative):Tables (8 pages)

	SHIPSAN (2016, 2011) [91, 92]	CDC (2016) [93]	CDC (2019)[78]
Prevention			
Before / Upon Embarkation			
Get vaccinated annually for influenza		X	
Vaccinate crew and passengers at least 2 weeks before voyage	X	X	X
Disseminate health questionnaire upon embarkation	X		
Deny boarding if signs & symptoms	X	X	X
Postpone travel when sick		X	X
Discuss antiviral treatment and chemoprophylaxis before travel			X
In case of pandemic, deny boarding	X		
In case of pandemic, request vaccination	X		
In case of pandemic, request and record epidemiological information	X		
On board the ship			
Implement hand washing / hand hygiene	X	X	X
Implement cough and sneezing etiquette	X	X	X
Implement disposal of dirty tissues protocol	X		

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Discussion

- As regards **prevention**, our SLR confirms an array of recommendations and guidelines that cover most instances and events both before embarkation and during travel and disembarkation of passengers from cruise ships.

- Equally, the SLR attests to extensive guidelines and recommendations on **mitigating the risk** of further contagion as a core component of an integrated public health strategy on board cruise ships.

- Additionally, the SLR confirmed the **diagnosis of cases** on board the ship is also well detailed in the literature of guidelines and recommendations.

- **On the contrary, screening and early identification** of communicable diseases on board the ship is less extensively detailed in guidelines and recommendations, despite the importance attached to the early identification as a prerequisite for risk mitigation.

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Conclusion

The review of these recommendations confirmed that prevention and risk mitigation are exhaustively addressed in the current literature. Diagnosis is also adequately detailed, referring to availability and accessibility of diagnostic means and resources.

Conversely, despite screening and early identification being cardinal in prompt diagnosis and effective risk mitigation, both of which are extensively presented as goals of public health interventions on board cruise ships, there appears to be **limited reference to tools and methods to perform large scale screening and early identification amongst passengers and crew on board cruise ship.**

Such interventions would probably necessitate use of wearables or other biosensing devices that are to-date not included in the relevant literature.

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How to move forward?

- **What are the state-of-the-art solutions that can address this gap?**
  - Workshop with internal partners – CEL and Columbia Blue to validate SLR and agree on state-of-the-art solutions required
  - Workshop with additional stakeholders – to gather insights on state-of-the-art solutions
  - List of state-of-the-art solutions that could be tested with passengers and crew
- **How willing are passengers and crew to endorse / implement/follow these solutions? What are their preferences?**
  - Stated preference survey with passengers – to measure preference for and willingness to endorse/follow proposed state-of-the-art solutions and to define barriers / concerns that would need to be addressed
  - Stated preference survey with crew – to measure preference for and willingness to endorse / implement proposed state-of-the-art solutions and to define barriers / concerns that need to be addressed
  - Both surveys in collaboration with CEL and Columbia Blue, fully anonymized, during cruises

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Question 1

- Based on your pre-reads, are **there any other practices or measures** implemented in your cruise ships for screening and early detection **not referred to** in the SLR?

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Quick recap of SLR findings on screening and detection

COVID - 19	ICS (2022)	CDC (2022)	CDC et al. (2022)	ECDC/EMCA (2021)	WHO (2020)
Before/Upon embarkation					
Perform day of embarkation screening for signs & symptoms		X	X		
Test newly embarking crew on day of embarkation and 3-5 days thereafter		X	X		
Screen embarking and disembarking crew and non-crew				X	
Require al contractors and visitors expected to remain on board ≥7 nights to quarantine			X		
Test all specimens for a ship's crew at same laboratory			X		
On board the ship					
Maintain screening and surveillance protocols to detect covid-like illness		X	X		X
Align testing protocols with CDC guidance		X			
Maintain on board capacity to conduct viral tests for SARS-COV-2		X	X	X	
Compensate any limitations in capacity with agreements with testing facilities on shore				X	
Perform routine-COVID-19 screening testing and monitoring of crew		X	X	X	
Prior to/ Upon disembarkation					
Test symptomatic passengers by PCR upon arrival in port	X				

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Quick recap of SLR findings on screening and detection

Influenza	SHIPSAN (2016, 2011)	CDC (2016)	CDC (2019)
Before/Upon embarkation			
Educate crew to recognize signs and symptoms	X		
Perform medical screening during embarkation to identify ill passengers			X
On board the ship			
Initiate case finding, upon identifying influenza outbreak	X		
Have rapid diagnostic influenza tests available onboard the ship	X		
Consider clinical diagnosis of influenza		X	

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Quick recap of SLR findings on screening and detection

Gastrointestinal Infections	SHIPSAN (2016, 2011)	CDC (2016 2018, 2019)	CDC (2019)
On board the ship			
Diagnose as early as possible	X		
Ensure clinical support to diagnose cases	X	X	
Use pre-agreed questionnaire maintained in ship's medical center	X	X	X
Collect fecal specimens for analysis during every outbreak	X	X	X
Collect and analyze epidemiological data to identify cause of outbreak	X		
Investigate galleys, potable water supplies or recreational water areas	X	X	X

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Quick recap of SLR findings on screening and detection

Legionella

Guidelines/recommendations	Screening and diagnosis
By: **EU SHIPSAN ACT JOINT ACTION (20122103)** Title: *European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. Second edition. (2016) and* **EU SHIP SANITATIN TRAINING NETWORK -SHIPSAN TRAINET PROJECT (2007206)** Title: *European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. European Commission Directorate General for health and consumers (2011)*	Confirm disease with microbiological diagnosis
By: **CDC** Title: *CDC Yellow Book 2020. Chapter 8: Cruise ship travel (2019)*	• Perform Legionella urine antigen testing • Culture lower respiratory secretions on selective media, which is important for detection of non–L. pneumophila serogroup 1 species and serogroups and is useful for comparing clinical isolates to environmental isolates during an outbreak investigation Administer prompt antibiotic treatment

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Feedback from partners

- To be completed during the workshop…

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Next steps

- **11/22 — SLR**: Review and finalize
- **01/23 — Workshop 1**: Hold workshop with internal stakeholders
- **02/23 — Workshop 2**: Hold workshop with external stakeholders
- **03/23 — Survey (1)**: Prepare and validate questionnaire (passenger and crew)
- **04/23 — Survey (2)**: Run survey (passenger and crew)
- **05/23 — Report**: Analyse results and prepare report for consortium

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PRESENTATION “MAIN GOALS OF SENSORS AND ACTUATORS”

Presented by Bérengère Lebental (Eiffel University)

Main goals of sensors and actuators

- Goal 1: prevent disease and epidemics occurrence
  - Goal 1.1: Reduction of risks of initial contamination
  - Goal 1.2: Prevention of disease colonisation
  - Goal 1.3: Record keeping on specific outbreaks

- Goal 2: early detection of diseases
  - Goal 2.1: Detection of specific diseases
  - Goal 2.2: Detection of symptoms:
    - 2.2.1: Fever
    - 2.2.2: Digestive tract symptoms
    - 2.2.3: Respiratory tract symptoms
  - Goal 2.4 Quick diagnosis of sick individuals by health-care team on board

- Goal 3: Act against disease/activation of mitigation measures
  - Goal 3.1: Manage the information flux (crew information; crew/passengers; crew/authorities)
  - Goal 3.2: Localization and confinement of people
    - 3.2.1: tracking of contaminated people
    - 3.2.2: execute and manage confinement protocols
  - Goal 3.3: Protect healthy people
    - 3.3.1: Treatment, including autonomous disinfection, of contaminated area
    - 3.3.2: Isolation of areas, including HVAC

Scenarios for sensors and actuators

- Passenger and symptoms tracking
  - Large ratio of passengers carrying smart wearable
  - Small number of additional fixed sensors in public spaces (fever portals, …)
  - Data gathering from pre-existing sensors aboard ship
- Detection of specific disease
  - Sensor outfitting sinks and toilets
- Prevention of disease colonisation
  - Cabin furniture and textiles outfitted with antibacterial coatings based on colloidal silver
- Prevention of disease transmission through air
  - Room air and HVAC purification with probiotic solution
  - HVAC control to enable confinement
  - Air quality monitoring
- Display and information sharing
  - Series of crew applications available on tablet and computer
  - Screen (+loudspeaker) enabling crew→ passenger information
  - Passenger app available on smart phone

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ABS | AETHON | HYDRUS | NTUA | UNIC | EPSILON | UNI EIFFEL
LEDRA | HPI | VAR | UTH | INF | RWO | CELESTYAL | UNPARALLEL
CNTLAB | ECO SENSE | COLUMBIA Blue | TSIKIS | ERGMASIN | WR | INTRA

HS4U
Horizon Europe | GA 101069937

Questions regarding sensors and actuators

- Global budget available per ship/per passengers to health-related actions?
- How to organize acceptability for passengers and crews of HS4U solutions (collection of personal data through smart wearables, cabin monitoring…)
- The MOST critical disease to detect ?
- The public spaces most critical to monitor ?
- Other technological solutions HS4U should include?

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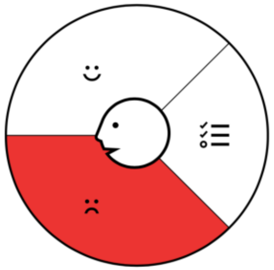
LEDRA | HPI | VAR | UTH | INF | RWO | CELESTYAL | UNPARALLEL
CNTLAB | ECO SENSE | COLUMBIA Blue | TSIKIS | ERGMASIN | WR | INTRA

PRESENTATION “MURAL – HS4U PAINS AND GAINS”

Presented by Paolo Franceschini (Variance Ascola)

CUSTOMER PAINS



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EXTREME

Budget available	Procedures different for every company	Acceptance of sensrs in their cabin?	
Costs of screening and prevention is never cost effective	Cruise ships loose a lot of passengers because of vacyns policies of cruise ships	Acceptance of wereable device	
What is the cost of an heartbreak VS costs of the solutions to prevent it	thermal cameras can also face recognise people. Maybe Rea-time location is not the only solution to track contacts	Acceptance of track of the sympthom through the app	
Assess costs of diseases case onboard	How much a cruise company wants to spend for this additional services/tools?	Monitoring of air quality in the room?	
Defend the company from sue	i.e. 20€ per bracelet, 3.000 people: €60.000 per cruise	Opinion on anti bacterial coating	
How can have 100% passengers accepting the technology (wereable)			
Not accurate data	You cannot refuse a booking if the passenger do not ant to accept the wereable		

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MODERATE

Customer Pains

Trigger Questions

Pains describe anything that annoys your customers before, during, and after trying to get a job done or simply prevents them from getting a job done. Pains also describe risks, that is, potential bad outcomes, related to getting a job done badly or not at all.

Use the following trigger questions to help you think of different potential customer pains:

1. How do your customers define too costly? Takes a lot of time, costs too much money, or requires substantial efforts?
2. What makes your customers feel bad? What are their frustrations, annoyances, or things that give them a headache?
3. How are current value propositions under performing for your customers? Which features are they missing? Are there performance issues that annoy them or malfunctions they cite?
4. What are the main difficulties and challenges your customers encounter? Do they understand how things work, have difficulties getting certain things done, or resist particular jobs for specific reasons?
5. What negative social consequences do your customers encounter or fear? Are they afraid of a loss of face, power, trust, or status?
6. What risks do your customers fear? Are they afraid of financial, social, or technical risks, or are they asking themselves what could go wrong?
7. What's keeping your customers awake at night? What are their big issues, concerns, and worries?
8. What common mistakes do your customers make? Are they using a solution the wrong way?
9. What barriers are keeping your customers from adopting a value proposition? Are there upfront investment costs, a steep learning curve, or other obstacles preventing adoption?

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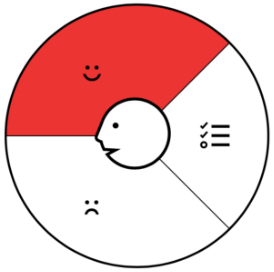
customer-pains-trigger-questions-1.pdf

CUSTOMER GAINS



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ESSENTIAL

Retrieve information quickly on potential diseases

FREE VISITS TO DOCTOR IN CASE OF SYNTHOMS

Identify the limit of virus on board

-

NICE TO HAVE

Customer Gains

Trigger Questions

Gains describe the outcomes and benefits your customers want. Some gains are required, expected, or desired by customers, and some would surprise them. Gains include functional utility, social gains, positive emotions, and cost savings.

Use the following trigger questions to help you think of different potential customer gains:

1. Which savings would make your customers happy? Which savings in terms of time, money, and effort would they value?
2. What quality levels do they expect, and what would they wish for more or less of?
3. How do current value propositions delight your customers? Which specific features do they enjoy? What performance and quality do they expect?
4. What would make your customers' jobs or lives easier? Could there be a flatter learning curve, more services, or lower costs of ownership?
5. What positive social consequences do your customers desire? What makes them look good? What increases their power or their status?
6. What are customers looking for most? Are they searching for good design, guarantees, specific or more features?
7. What do customers dream about? What do they aspire to achieve, or what would be a big relief to them?
8. How do your customers measure success and failure? How do they gauge performance or cost?
9. What would increase your customers' likelihood of adopting a value proposition? Do they desire lower cost, less investment, lower risk, or better quality?

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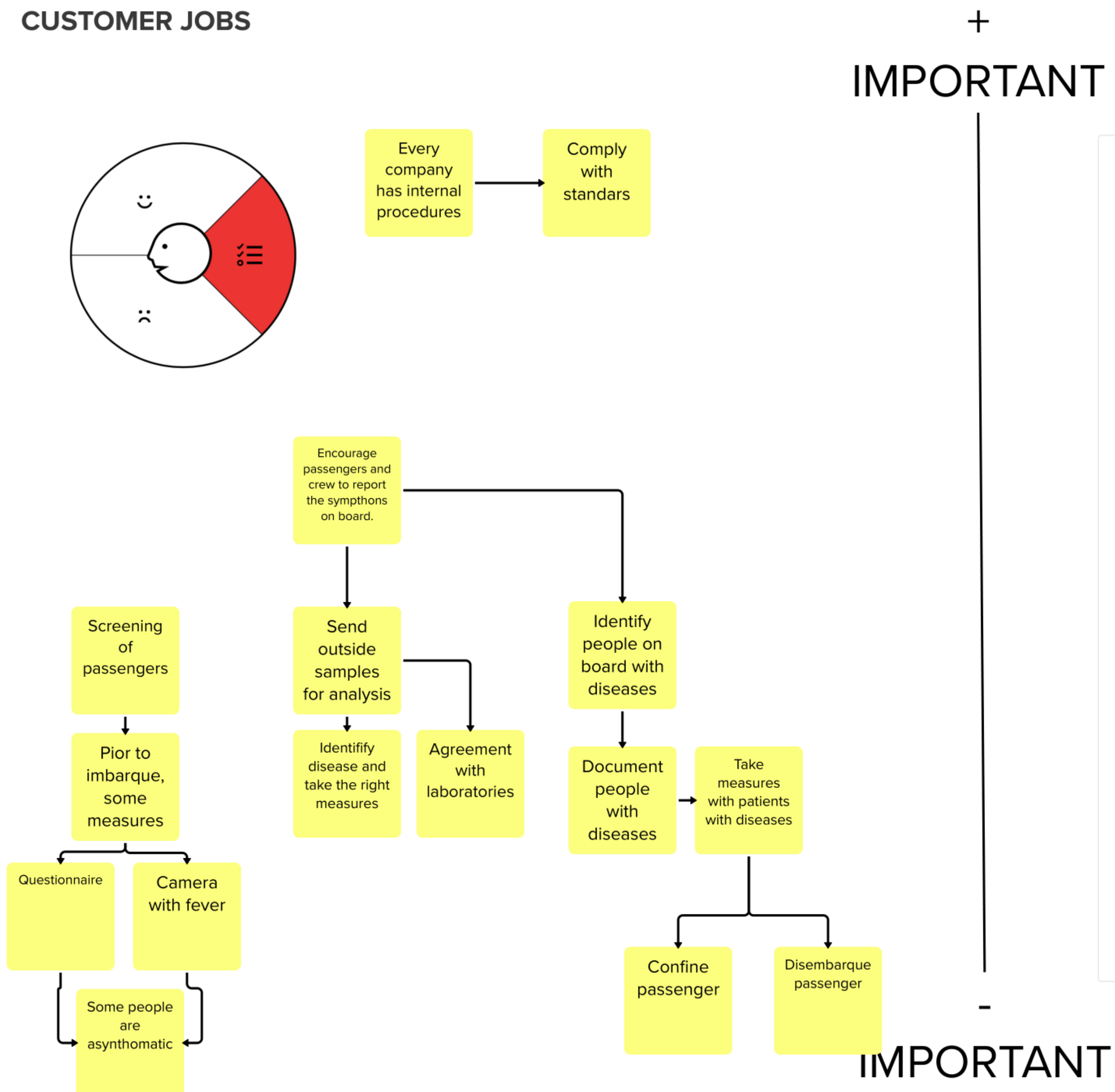
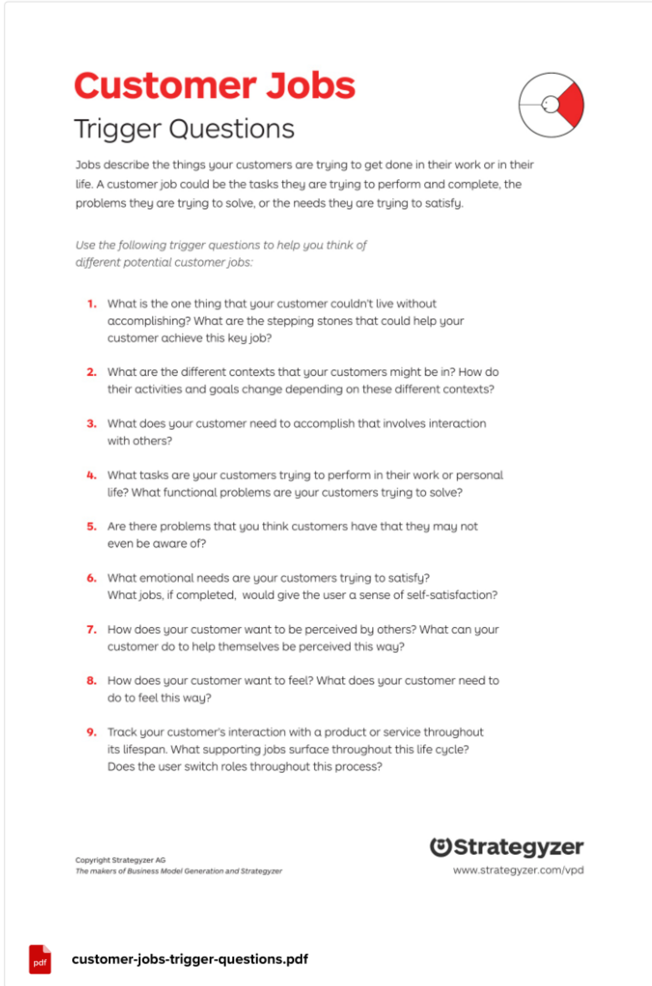
www.strategyzer.com/vpd

customer-gains-trigger-questions.pdf

CUSTOMER JOBS





Customer Jobs

Trigger Questions

Jobs describe the things your customers are trying to get done in their work or in their life. A customer job could be the tasks they are trying to perform and complete, the problems they are trying to solve, or the needs they are trying to satisfy.

Use the following trigger questions to help you think of different potential customer jobs:

1. What is the one thing that your customer couldn't live without accomplishing? What are the stepping stones that could help your customer achieve this key job?
2. What are the different contexts that your customers might be in? How do their activities and goals change depending on these different contexts?
3. What does your customer need to accomplish that involves interaction with others?
4. What tasks are your customers trying to perform in their work or personal life? What functional problems are your customers trying to solve?
5. Are there problems that you think customers have that they may not even be aware of?
6. What emotional needs are your customers trying to satisfy? What jobs, if completed, would give the user a sense of self-satisfaction?
7. How does your customer want to be perceived by others? What can your customer do to help themselves be perceived this way?
8. How does your customer want to feel? What does your customer need to do to feel this way?
9. Track your customer's interaction with a product or service throughout its lifespan. What supporting jobs surface throughout this life cycle? Does the user switch roles throughout this process?

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customer-jobs-trigger-questions.pdf

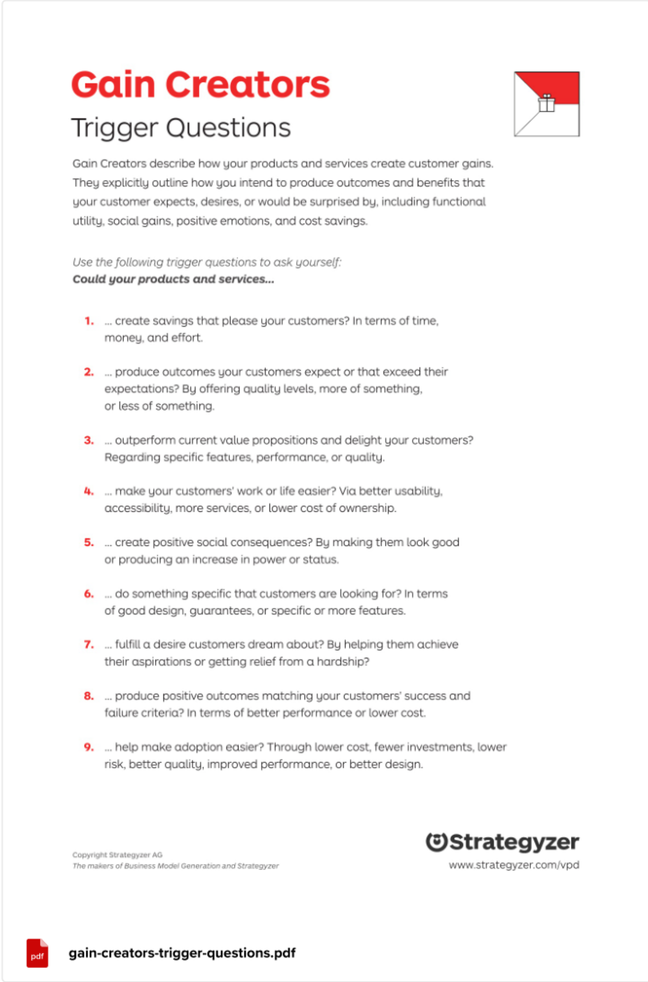
PAIN RELIEVERS

+

ESSENTIAL

Economic incentives to use a wereable

Free visit every day to the doctor, if you do not accept the wereable



Gain Creators

Trigger Questions

Gain Creators describe how your products and services create customer gains. They explicitly outline how you intend to produce outcomes and benefits that your customer expects, desires, or would be surprised by, including functional utility, social gains, positive emotions, and cost savings.

Use the following trigger questions to ask yourself:
Could your products and services...

1. ... create savings that please your customers? In terms of time, money, and effort.
2. ... produce outcomes your customers expect or that exceed their expectations? By offering quality levels, more of something, or less of something.
3. ... outperform current value propositions and delight your customers? Regarding specific features, performance, or quality.
4. ... make your customers' work or life easier? Via better usability, accessibility, more services, or lower cost of ownership.
5. ... create positive social consequences? By making them look good or producing an increase in power or status.
6. ... do something specific that customers are looking for? In terms of good design, guarantees, or specific or more features.
7. ... fulfill a desire customers dream about? By helping them achieve their aspirations or getting relief from a hardship?
8. ... produce positive outcomes matching your customers' success and failure criteria? In terms of better performance or lower cost.
9. ... help make adoption easier? Through lower cost, fewer investments, lower risk, better quality, improved performance, or better design.

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gain-creators-trigger-questions.pdf

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NICE TO HAVE

PRODUCTS AND SERVICES

+

ESSENTIAL

App to report sympthoms

Smartwatch

-

NICE TO HAVE

ANNEX 2 – Questionnaires

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΠΛΗΡΩΜΑΤΟΣ

Εισαγωγή

Σας ευχαριστούμε πολύ για τη συμμετοχή σας στην έρευνα αυτή, η οποία υλοποιείται στο πλαίσιο του έργου HS4U (Healthy Ship For You). Το πρόγραμμα HS4U χρηματοδοτείται από την Ευρωπαϊκή Επιτροπή (HORIZON Europe – Κωδικός Επιχορήγησης 101069937). Σκοπός αυτού του προγράμματος είναι η εξασφάλιση της προστασίας της δημόσιας υγείας κατά την κρουαζιέρα, με την ενσωμάτωση τεχνολογικών λύσεων σε διάφορα τμήματα του πλοίου, για την έγκαιρη ανίχνευση των τεσσάρων πιο συχνά παρατηρούμενων μεταδοτικών λοιμώξεων, δηλαδή της COVID-19, της γρίπης, των γαστρεντερικών λοιμώξεων και της λεγεωνέλλας. Σας παρακαλούμε να απαντήσετε σε κάθε ερώτηση αυτής της έρευνας όσο το δυνατόν πιο ειλικρινά.

Οι δύο πρώτες ενότητες της έρευνας αφορούν σε βασικά κοινωνικοδημογραφικά χαρακτηριστικά, προηγούμενη εργασιακή εμπειρία σε κρουαζιέρα, καθώς και το ιατρικό σας ιστορικό. Οι απαντήσεις είναι πλήρως ανώνυμες και δεν μπορούν – σε καμία περίπτωση – να συσχετιστούν με εσάς, ως άτομο. Το Ινστιτούτο Πολιτικής της Υγείας, το οποίο είναι επιστημονικά υπεύθυνο για την ανάλυση των απαντήσεων και την τελική έκθεση, δεν θα συλλέξει, δεν θα αποκτήσει πρόσβαση, δεν θα αποθηκεύσει ούτε θα επεξεργαστεί μη ανώνυμα δεδομένα.

Η τρίτη ενότητα της έρευνας διερευνά την προθυμία σας να επιτρέψετε την εφαρμογή ή να υιοθετήσετε διάφορες τεχνολογικές λύσεις για τον προσυμπτωματικό έλεγχο και την έγκαιρη ανίχνευση εξάρσεων μεταδοτικών ασθενειών. Αυτές οι λύσεις θα εγκατασταθούν είτε στις καμπίνες είτε σε κοινόχρηστους χώρους του κρουαζιερόπλοιου. Υπάρχουν, επίσης, ορισμένες λύσεις, οι οποίες περιλαμβάνουν συσκευές που μετρούν σε πραγματικό χρόνο τις ζωτικές ενδείξεις των επιβατών και του πληρώματος.

Συμμετέχοντας σε αυτήν την έρευνα, παρέχετε τη συγκατάθεσή σας στο Ινστιτούτο Πολιτικής της Υγείας να αναλύσει και να επεξεργαστεί τις πλήρως ανωνυμοποιημένες απαντήσεις σας για την εκπόνηση μιας επιστημονικής δημοσίευσης.

Σας ευχαριστούμε θερμά για τον χρόνο σας.

ΣΥΓΚΑΤΑΘΕΣΗ ΜΕΤΑ ΑΠΟ ΕΝΗΜΕΡΩΣΗ ΓΙΑ ΣΥΜΜΕΤΟΧΗ ΣΤΗΝ ΕΡΕΥΝΑ

Έχοντας διαβάσει και κατανοήσει τα παραπάνω, παρέχω τη συγκατάθεσή μου για τη χρήση των ανωνυμοποιημένων δεδομένων που θα παρέχω για την εκπόνηση μιας επιστημονικής δημοσίευσης.

	Ναι	Ευχαριστούμε. Μπορείτε να προχωρήσετε στις ερωτήσεις της έρευνας
	Όχι	Σας ευχαριστούμε για το χρόνο σας. Δεν μπορείτε να συμμετέχετε στην έρευνα

Υπογραφή:

Ημερομηνία:

Ενότητα 1. Δημογραφικά χαρακτηριστικά.

Τα δημογραφικά δεδομένα συλλέγονται για να μας βοηθήσουν να κατανοήσουμε εάν οι απαντήσεις στην έρευνα επηρεάζονται από προσωπικά χαρακτηριστικά όπως το φύλο, η ηλικία ή η χώρα διαμονής.

1. Φύλο

   Παρακαλούμε επιλέξτε μόνο μία απάντηση.

Άρρεν	
Θήλυ	

2. Χώρα διαμονής

   Σημειώστε τη χώρα στην οποία διαμένετε.

3. Έτος γέννησης (παρακαλούμε χρησιμοποιήστε τέσσερα ψηφία, π.χ. 1962)

. . . .

4. Επίπεδο εκπαίδευσης (υψηλότερο)

   Παρακαλούμε επιλέξτε μόνο μία απάντηση.

Λιγότερο από απολυτήριο γυμνασίου	
Απολυτήριο Λυκείου ή ισότιμο	
Πτυχίο Τεχνικής Σχολής	
Πτυχίο Πανεπιστημίου	
Μεταπτυχιακό ή διδακτορικό δίπλωμα	
Άλλο (παρακαλούμε διευκρινίστε)	

Ενότητα 2. Προφίλ πληρώματος.

Τα δεδομένα του προφίλ θα εμπλουτίσουν την ανάλυσή μας σε σχέση με τις τεχνολογικές, ταξιδιωτικές και ιατρικές προτιμήσεις και εμπειρίες των μελών του πληρώματος.

1. Κατά μέσο όρο, για πόση ώρα σε καθημερινή βάση κάνετε χρήση της τεχνολογίας για να εκτελέσετε τις ακόλουθες εργασίες;
   Οι ερωτήσεις στοχεύουν στο να κατανοήσουμε εάν το μέλος του πληρώματος είναι συχνός χρήστης της τεχνολογίας.

Εργασία	**ώρες καθημερινά (κατά μέσο όρο)**
Για να εκτελώ την εργασία μου / τα καθήκοντά μου	
Για να ενημερώνομαι για τις ειδήσεις	
Για την επικοινωνία με φίλους και οικογένεια	
Για να παρακολουθώ τις ζωτικές ενδείξεις της υγείας μου / τα προγράμματα άσκησης μου / τα πρότυπα ύπνου μου	
Για ψυχαγωγικούς σκοπούς (μέσα κοινωνικής δικτύωσης, συνδρομητικές πλατφόρμες κ.λπ.)	

2. Έχετε παρατηρήσει κάποια μέτρα ασφάλειας για την υγεία ή την υγιεινή στο πλοίο, ιδιαίτερα για μεταδοτικές ασθένειες;

Ναι	
Όχι	

3. Εάν ναι, θεωρείτε ότι είναι ικανοποιητικά και επαρκή;
   Παρακαλούμε απαντήστε μόνο εάν η απάντηση στην προηγούμενη ερώτηση ήταν «ναι».

Ναι	
Μάλλον ναι	
Δεν είμαι σίγουρος	
Μάλλον όχι	
Όχι	

4. Είναι η πρώτη φορά που δουλεύετε σε κρουαζιερόπλοιο;
   Η ερώτηση συσχετίζει τις απαντήσεις με προηγούμενη τυχόν εργασιακή εμπειρία σε κρουαζιέρα.

Ναι	
Όχι	

5. Εάν όχι , πόσες φορές έχετε δουλέψει σε κρουαζιερόπλοιο μέχρι σήμερα;
Παρακαλούμε επιλέξτε μόνο μία απάντηση.

1	
2-3	
Περισσότερες από 3	

6. Έχετε ποτέ διαγνωστεί με κάποια χρόνια πάθηση;
Αυτή η ερώτηση στοχεύει να συσχετίσει τις προτιμήσεις του πληρώματος, με βάση την ύπαρξη μιας ή πολλαπλών συννοσηροτήτων.

Ναι	
Όχι	

7. Εάν ναι, έχετε νοσηλευτεί ποτέ για αυτήν την πάθηση;
Αυτή η ερώτηση στοχεύει να συσχετίσει τις προτιμήσεις του πληρώματος, με βάση τη σοβαρότητα των συννοσηροτήτων τους.

Ναι	
Όχι	

8. Είστε εξοικειωμένοι με τις ακόλουθες μεταδοτικές ασθένειες;
Μπορείτε να επιλέξετε περισσότερες από μία απαντήσεις.
Αυτή η ερώτηση στοχεύει να καταγράψει τις τρέχουσες γνώσεις του πληρώματος για τις πιο κοινές μεταδοτικές ασθένειες στα κρουαζιερόπλοια.

	Ναι	Όχι
COVID-19		
Γρίπη		
Γαστρεντερικές λοιμώξεις		
Λεγεωνέλλα		

9. Έχετε προσβληθεί ποτέ από μία από αυτές τις ασθένειες;
Αυτή η ερώτηση στοχεύει να καταγράψει το επίπεδο συνειδητοποίησης των επιπτώσεων των ασθενειών αυτών μεταξύ των μελών του πληρώματος.

Ναι	
Όχι	

10. Αν ναι, χρειαστήκατε νοσηλεία για αυτές;
Αυτή η ερώτηση στοχεύει να καταγράψει τη σοβαρότητα των επιπτώσεων στο πλήρωμα και κατά πόσο μπορεί να επηρεάσει τις προτιμήσεις τους.

Ναι	
Όχι	

11. Φοβάστε μήπως έρθετε σε επαφή με μια μεταδοτική ασθένεια ή μόλυνση στο πλοίο;

Funded by
the European Union

Παρακαλούμε επιλέξτε μόνο μία απάντηση.

Ναι	
Μάλλον ναι	
Δεν είμαι σίγουρος	
Μάλλον όχι	
Όχι	

Ενότητα 3. Προθυμία αποδοχής τεχνικών λύσεων για τον έλεγχο και την έγκαιρη διάγνωση εξάρσεων μεταδοτικών ασθενειών.

1. Συμφωνείτε με τη χρήση των παρακάτω τεχνολογικών λύσεων σε ένα κρουαζιερόπλοιο για τον έγκαιρο εντοπισμό μιας έξαρσης μεταδοτικής ασθένειας;
   Παρακαλούμε, δηλώστε την προτίμησή σας σε κάθε σειρά παρακάτω.

	Συμφωνώ απολύτως	Συμφωνώ	Ουδέτερος	Διαφωνώ	Διαφωνώ απολύτως
Κάμερες που ανιχνεύουν επιβάτες με πυρετό					
Συσκευές (π.χ. smartwatch) για την παρακολούθηση της υγείας					
Εξοπλισμός του νεροχύτη και της τουαλέτας της καμπίνας με αισθητήρες ανίχνευσης ιών					
Εξοπλισμός της καμπίνας με αισθητήρες μέτρησης της ποιότητας του αέρα					
Εγκατάσταση καθαρισμού αέρα στην καμπίνα και το σύστημα κλιματισμού					
Επικάλυψη των επιφανειών της καμπίνας ή/και κοινόχρηστων χώρων με αντιβακτηριδιακά/αντιικά υλικά					
Χρήση των τηλεοράσεων στις καμπίνες ή/και στους δημόσιους χώρους για την καθοδήγηση και την παροχή συμβουλών σε πραγματικό χρόνο σε περιπτώσεις έξαρσης ασθενειών					

2. Εάν «συμφωνείτε» ή «συμφωνείτε απόλυτα» με οποιαδήποτε από τις παραπάνω λύσεις, γιατί;
   Παρακαλούμε, δηλώστε την προτίμησή σας σε κάθε σειρά παρακάτω.

	Συμφωνώ απολύτως	Συμφωνώ	Ουδέτερος	Διαφωνώ	Διαφωνώ απολύτως
Είμαι υπέρ της χρήσης οποιασδήποτε νέας τεχνολογίας					
Θα καθησυχάσει τυχόν ανησυχίες μου σχετικές με την υγεία κατά τη διάρκεια της κρουαζιέρας					
Άλλο (παρακαλούμε διευκρινίστε)					

3. Εάν «διαφωνείτε» ή «διαφωνείτε απόλυτα» με οποιαδήποτε από τις παραπάνω λύσεις, γιατί;
   Παρακαλούμε, δηλώστε την προτίμησή σας σε κάθε σειρά παρακάτω.

	Συμφωνώ απολύτως	Συμφωνώ	Ουδέτερος	Διαφωνώ	Διαφωνώ απολύτως
Ανησυχώ για την ασφάλεια των δεδομένων υγείας μου					
Ανησυχώ μήπως στιγματιστώ κοινωνικά σε περίπτωση ασθένειας					
Ανησυχώ για τις επιπτώσεις που μπορεί να έχει στην υγεία μου (ηλεκτρομαγνητική ακτινοβολία κ.λπ.)					
Ανησυχώ μήπως νιώσω άβολα κατά τη διάρκεια της κρουαζιέρας (θα μου προκαλούσε άγχος)					
Δεν θέλω να με παρακολουθούν					
Άλλο (παρακαλούμε διευκρινίστε)					

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΕΠΙΒΑΤΩΝ

Εισαγωγή

Σας ευχαριστούμε πολύ για τη συμμετοχή σας στην έρευνα αυτή, η οποία υλοποιείται στο πλαίσιο του Προγράμματος HS4U (Healthy Ship For You). Το Πρόγραμμα HS4U χρηματοδοτείται από την Ευρωπαϊκή Επιτροπή (HORIZON Europe – Κωδικός Επιχορήγησης 101069937). Σκοπός αυτού του προγράμματος είναι η εξασφάλιση της προστασίας της δημόσιας υγείας κατά την κρουαζιέρα, με την ενσωμάτωση τεχνολογικών λύσεων σε διάφορα τμήματα του πλοίου, για την έγκαιρη ανίχνευση των τεσσάρων πιο συχνά παρατηρούμενων μεταδοτικών λοιμώξεων, δηλαδή της COVID-19, της γρίπης, των γαστρεντερικών λοιμώξεων και της λεγεωνέλλας. Σας παρακαλούμε να απαντήσετε σε κάθε ερώτηση αυτής της έρευνας όσο το δυνατόν πιο ειλικρινά.

Οι δύο πρώτες ενότητες της έρευνας αφορούν σε βασικά κοινωνικοδημογραφικά χαρακτηριστικά, προηγούμενη εμπειρία με κρουαζιέρα, καθώς και το ιατρικό σας ιστορικό. Οι απαντήσεις είναι πλήρως ανώνυμες και δεν μπορούν – σε καμία περίπτωση – να συσχετιστούν με εσάς, ως άτομο. Το Ινστιτούτο Πολιτικής της Υγείας, το οποίο είναι επιστημονικά υπεύθυνο για την ανάλυση των απαντήσεων και την τελική έκθεση, δεν θα συλλέξει, δεν θα αποκτήσει πρόσβαση, δεν θα αποθηκεύσει ούτε θα επεξεργαστεί μη ανώνυμα δεδομένα.

Η τρίτη ενότητα της έρευνας διερευνά την προθυμία σας να επιτρέψετε την εφαρμογή ή να υιοθετήσετε διάφορες τεχνολογικές λύσεις για τον προσυμπτωματικό έλεγχο και την έγκαιρη ανίχνευση εξάρσεων μεταδοτικών ασθενειών. Αυτές οι λύσεις θα εγκατασταθούν είτε στις καμπίνες είτε σε κοινόχρηστους χώρους του κρουαζιερόπλοιου. Υπάρχουν, επίσης, ορισμένες λύσεις, οι οποίες περιλαμβάνουν συσκευές που μετρούν σε πραγματικό χρόνο τις ζωτικές ενδείξεις των επιβατών και του πληρώματος.

Συμμετέχοντας σε αυτήν την έρευνα, παρέχετε τη συγκατάθεσή σας στο Ινστιτούτο Πολιτικής της Υγείας να αναλύσει και να επεξεργαστεί τις πλήρως ανωνυμοποιημένες απαντήσεις σας για την εκπόνηση μιας επιστημονικής δημοσίευσης.

Σας ευχαριστούμε θερμά για τον χρόνο σας.

ΣΥΓΚΑΤΑΘΕΣΗ ΜΕΤΑ ΑΠΟ ΕΝΗΜΕΡΩΣΗ ΓΙΑ ΣΥΜΜΕΤΟΧΗ ΣΤΗΝ ΕΡΕΥΝΑ

Έχοντας διαβάσει και κατανοήσει τα παραπάνω, παρέχω τη συγκατάθεσή μου για τη χρήση των ανωνυμοποιημένων δεδομένων που θα παρέχω για την εκπόνηση μιας επιστημονικής δημοσίευσης.

	Ναι	Ευχαριστούμε. Μπορείτε να προχωρήσετε στις ερωτήσεις της έρευνας
	Όχι	Σας ευχαριστούμε για το χρόνο σας. Δεν μπορείτε να συμμετέχετε στην έρευνα

Υπογραφή:

Ημερομηνία:

Funded by the European Union

Ενότητα 1. Δημογραφικά χαρακτηριστικά.

Τα δημογραφικά δεδομένα συλλέγονται για να μας βοηθήσουν να κατανοήσουμε εάν οι απαντήσεις στην έρευνα επηρεάζονται από προσωπικά χαρακτηριστικά όπως το φύλο, η ηλικία ή η χώρα διαμονής.

1. Φύλο

Παρακαλούμε επιλέξτε μόνο μία απάντηση.

Άρρεν	
Θήλυ	

2. Χώρα διαμονής

Σημειώστε τη χώρα στην οποία διαμένετε.

3. Έτος γέννησης (παρακαλούμε χρησιμοποιήστε τέσσερα ψηφία, π.χ. 1962)

. . . .

4. Επίπεδο εκπαίδευσης (υψηλότερο)

Παρακαλούμε επιλέξτε μόνο μία απάντηση.

Λιγότερο από απολυτήριο γυμνασίου	
Απολυτήριο Λυκείου ή ισότιμο	
Πτυχίο Τεχνικής Σχολής	
Πτυχίο Πανεπιστημίου	
Μεταπτυχιακό ή διδακτορικό δίπλωμα	
Άλλο (παρακαλούμε διευκρινίστε)	

5. Εργασιακή κατάσταση

Παρακαλούμε επιλέξτε μόνο μία απάντηση.

Μισθωτός / αυτοαπασχολούμενος	
Άνεργος	
Συνταξιούχος	
Ανάπηρος, μη ικανός προς εργασία	
Άλλο (παρακαλούμε διευκρινίστε)	

6. Οικογενειακή κατάσταση

Παρακαλούμε επιλέξτε μόνο μία απάντηση.

Δεν είμαι παντρεμένος/η ή δεν ζω με σύντροφο, δεν έχω παιδιά	
Δεν είμαι παντρεμένος ή δεν ζω με σύντροφο, έχω παιδιά	
Παντρεμένος/η ή συζώ, δεν έχω παιδιά	
Παντρεμένος/η ή συζώ, έχω παιδιά	

Διαζευγμένος/η, δεν έχω παιδιά	
Διαζευγμένος/η, έχω παιδιά	
Χήρος/α, δεν έχω παιδιά	
Χήρος/α, έχω παιδιά	
Άλλο (παρακαλούμε διευκρινίστε)	

Ενότητα 2. Προφίλ επιβατών.

Τα δεδομένα του προφίλ θα εμπλουτίσουν την ανάλυσή μας σε σχέση με τις τεχνολογικές, ταξιδιωτικές και ιατρικές προτιμήσεις και εμπειρίες των επιβατών.

1. Κατά μέσο όρο, για πόση ώρα σε καθημερινή βάση κάνετε χρήση της τεχνολογίας για να εκτελέσετε τις ακόλουθες εργασίες;
   Οι ερωτήσεις στοχεύουν στο να κατανοήσουμε εάν ο επιβάτης είναι συχνός χρήστης της τεχνολογίας.

Εργασία	**ώρες καθημερινά (κατά μέσο όρο)**
Για να εκτελώ την εργασία μου / τα καθήκοντά μου	
Για να ενημερώνομαι για τις ειδήσεις	
Για την επικοινωνία με φίλους και οικογένεια	
Για να παρακολουθώ τις ζωτικές ενδείξεις της υγείας μου / τα προγράμματα άσκησης μου / τα πρότυπα ύπνου μου	
Για ψυχαγωγικούς σκοπούς (μέσα κοινωνικής δικτύωσης, συνδρομητικές πλατφόρμες κ.λπ.)	

2. Έχετε παρατηρήσει κάποια μέτρα ασφάλειας για την υγεία ή την υγιεινή στο πλοίο, ιδιαίτερα για μεταδοτικές ασθένειες;

Ναι	
Όχι	

3. Εάν ναι, θεωρείτε ότι είναι ικανοποιητικά και επαρκή;
   Παρακαλούμε απαντήστε μόνο εάν η απάντηση στην προηγούμενη ερώτηση ήταν «ναι».

Ναι	
Μάλλον ναι	
Δεν είμαι σίγουρος	
Μάλλον όχι	
Όχι	

4. Είναι η πρώτη σας φορά σε κρουαζιέρα;

Η ερώτηση συσχετίζει τις απαντήσεις με προηγούμενη τυχόν εμπειρία κρουαζιέρας.

Ναι	
Όχι	

5. Εάν όχι, πόσες φορές έχετε συμμετάσχει σε κρουαζιέρα μέχρι σήμερα;
Παρακαλούμε επιλέξτε μόνο μία απάντηση.

1	
2-3	
Περισσότερες από 3	

6. Έχετε ποτέ διαγνωστεί με κάποια χρόνια πάθηση;
Αυτή η ερώτηση στοχεύει να συσχετίσει τις προτιμήσεις των επιβατών, με βάση την ύπαρξη μιας ή πολλαπλών συννοσηροτήτων.

Ναι	
Όχι	

7. Εάν ναι, έχετε νοσηλευτεί ποτέ για αυτήν την πάθηση;
Αυτή η ερώτηση στοχεύει να συσχετίσει τις προτιμήσεις των επιβατών, με βάση τη σοβαρότητα των συννοσηροτήτων τους.

Ναι	
Όχι	

8. Είστε εξοικειωμένοι με τις ακόλουθες μεταδοτικές ασθένειες;
Μπορείτε να επιλέξετε περισσότερες από μία απαντήσεις.
Αυτή η ερώτηση στοχεύει να καταγράψει τις τρέχουσες γνώσεις των επιβατών για τις πιο κοινές μεταδοτικές ασθένειες στα κρουαζιερόπλοια.

	Ναι	Όχι
COVID-19		
Γρίπη		
Γαστρεντερικές λοιμώξεις		
Λεγεωνέλλα		

9. Έχετε προσβληθεί ποτέ από μία από αυτές τις ασθένειες;
Αυτή η ερώτηση στοχεύει να καταγράψει το επίπεδο συνειδητοποίησης των επιπτώσεων των ασθενειών αυτών μεταξύ των επιβατών.

Ναι	
Όχι	

10. Αν ναι, χρειαστήκατε νοσηλεία για αυτές;

Αυτή η ερώτηση στοχεύει να καταγράψει τη σοβαρότητα των επιπτώσεων στους επιβάτες και κατά πόσο μπορεί να επηρεάσει τις προτιμήσεις τους.

Ναι	
Όχι	

11. Φοβάστε μήπως έρθετε σε επαφή με μια μεταδοτική ασθένεια ή μόλυνση στο πλοίο;

Παρακαλούμε επιλέξτε μόνο μία απάντηση.

Ναι	
Μάλλον ναι	
Δεν είμαι σίγουρος	
Μάλλον όχι	
Όχι	

Ενότητα 3. Προθυμία αποδοχής τεχνικών λύσεων για τον έλεγχο και την έγκαιρη διάγνωση εξάρσεων μεταδοτικών ασθενειών.

1. Συμφωνείτε με τη χρήση των παρακάτω τεχνολογικών λύσεων σε ένα κρουαζιερόπλοιο για τον έγκαιρο εντοπισμό μιας έξαρσης μεταδοτικής ασθένειας;

Παρακαλούμε, δηλώστε την προτίμησή σας σε κάθε σειρά παρακάτω.

	Συμφωνώ απολύτως	Συμφωνώ	Ουδέτερος	Διαφωνώ	Διαφωνώ απολύτως
Κάμερες που ανιχνεύουν επιβάτες με πυρετό					
Συσκευές (π.χ. smartwatch) για την παρακολούθηση της υγείας					
Εξοπλισμός του νεροχύτη και της τουαλέτας της καμπίνας με αισθητήρες ανίχνευσης ιών					
Εξοπλισμός της καμπίνας με αισθητήρες μέτρησης της ποιότητας του αέρα					
Εγκατάσταση καθαρισμού αέρα στην καμπίνα και το σύστημα κλιματισμού					
Επικάλυψη των επιφανειών της καμπίνας ή/και κοινόχρηστων χώρων με αντιβακτηριδιακά/αντιικά υλικά					
Χρήση των τηλεοράσεων στις καμπίνες ή/και στους δημόσιους χώρους για την καθοδήγηση και την παροχή συμβουλών σε πραγματικό χρόνο σε περιπτώσεις έξαρσης ασθενειών					

2. Εάν «συμφωνείτε» ή «συμφωνείτε απόλυτα» με οποιαδήποτε από τις παραπάνω λύσεις, γιατί;
Παρακαλούμε, δηλώστε την προτίμησή σας σε κάθε σειρά παρακάτω.

	Συμφωνώ απολύτως	Συμφωνώ	Ουδέτερος	Διαφωνώ	Διαφωνώ απολύτως
Είμαι υπέρ της χρήσης οποιασδήποτε νέας τεχνολογίας					
Θα καθησυχάσει τυχόν ανησυχίες μου σχετικές με την υγεία κατά τη διάρκεια της κρουαζιέρας					
Άλλο (παρακαλούμε διευκρινίστε)					

3. Εάν «διαφωνείτε» ή «διαφωνείτε απόλυτα» με οποιαδήποτε από τις παραπάνω λύσεις, γιατί;
Παρακαλούμε, δηλώστε την προτίμησή σας σε κάθε σειρά παρακάτω.

	Συμφωνώ απολύτως	Συμφωνώ	Ουδέτερος	Διαφωνώ	Διαφωνώ απολύτως
Ανησυχώ για την ασφάλεια των δεδομένων υγείας μου					
Ανησυχώ μήπως στιγματιστώ κοινωνικά σε περίπτωση ασθένειας					
Ανησυχώ για τις επιπτώσεις που μπορεί να έχει στην υγεία μου (ηλεκτρομαγνητική ακτινοβολία κ.λπ.)					
Ανησυχώ μήπως νιώσω άβολα κατά τη διάρκεια της κρουαζιέρας (θα μου προκαλούσε άγχος)					
Δεν θέλω να με παρακολουθούν					
Άλλο (παρακαλούμε διευκρινίστε)					

CREW QUESTIONNAIRE

Introduction

We would like to thank you for participating in this survey. This survey is implemented under the framework of the HS4U project (Healthy Ship For You), which is funded by the European Commission (HORIZON Europe – Grant Agreement 101069937). The purpose of this project is the safe proofing of cruises by integrating the different departments of the cruise ship with technological solutions for early detection of the four most prevalent communicable diseases, namely COVID-19, Influenza, Gastrointestinal diseases, and Legionella.

We kindly ask you to answer every question of this survey as honestly as possible.

The first two sections of the survey enquire after basic sociodemographic characteristics, previous experience with working on cruises and medical history. The answers are fully anonymized and cannot – in any case - be associated with you, as a person. The Health Policy Institute, which is scientifically responsible for the analysis of responses and the final report, will never collect, acquire access to, store or process non-anonymized data.

The third section of the survey probes into your willingness to adopt several technological solutions for screening and early detection of communicable diseases' outbreaks. These solutions will either be installed in your cabin or at public places of the cruise ship. There are also some solutions, which include wearable devices measuring in real time vital signs of passengers and crew.

By participating in this survey, you provide your consent to the Health Policy Institute to analyse and process your fully anonymized answers for purposes of preparing a scientific publication.

We kindly thank you for your time.

INFORMED CONSENT TO PARTICIPATE IN THE SURVEY

Having read and understood the above, I provide my informed consent for the use of the anonymized data I shall be providing for the purposes of the preparation of a scientific publication.

	Yes	Thank you. You may proceed to the survey questions
	No	Thank you for your time. You may not participate in the survey

Signed:

Dated:

Section 1. Demographic characteristics.

Demographic data is collected to help us understand whether responses to the survey are affected by personal characteristics such as gender, age, or country of residence.

1. What is your gender?
Please, choose only one answer.

Male	
Female	

2. What is your country of residence?
Please indicate the country where you reside.

3. Please insert the year of your birth, using four digits, e.g., 1962

. . . .

4. What is the highest degree you hold or level of education you have completed?
Please, choose only one answer.

Less than a high school degree	
High school degree or equivalent	
College degree	
Bachelor’s degree	
Master’s or PhD degree	
Other (please specify)	

Section 2. Crew profile.

Profile data will inform our analysis with respect to crew technological, travel and medical preferences and experiences.

1. How long on average do you use technology daily to perform the following tasks, if at all?
This questions aims at understanding whether the crew member is a frequent technology user.

Task	**Daily hours (on average)**
To perform my work / duties	
To keep up to date with news	
To communicate with friends and family	
To monitor my health vitals / exercise routines / sleep patterns	
For entertainment purposes (social media, subscription platforms etc.)	

2. Have you been acquainted with any health or sanitation safety measures in place on board the ship, particularly for communicable diseases?

Yes	
No	

3. If yes, do you find them adequate and sufficient?
Provide an answer only if your previous answer was "yes".

Yes	
Probably yes	
I am not sure	
Probably no	
No	

4. Is this the first time you have worked on a cruise?
Please, choose only one answer.
This questions aims at understanding whether this is your first time working on a cruise or you have been exposed to the cruise working environment before.

Yes	
No	

5. If no, how many times have you worked on a cruise to-date?
Please, choose only one answer.

1	
2-3	
More than 3	

6. Have you ever been diagnosed with a chronic condition?
This question aims to inform correlations with crew preferences, based on the presence of one or multiple comorbidities.

Yes	
No	

7. If yes, have you ever been hospitalized for this condition?
This question aims to inform correlations with crew preferences, based on the severity of their comorbidities.

Yes	
No	

8. Are you familiar with the following communicable diseases?
You may choose more than one answer.
This question aims to record current crew knowledge of the most common communicable diseases on board cruise ships.

	Yes	No
Covid-19		
Influenza		
Gastrointestinal diseases		
Legionella		

9. Have you ever been affected by one of these diseases?
This question aims to record level of awareness of the impact of these diseases amongst crew.

Yes	
No	

10. If yes, were you hospitalized?
This question aims to record severity of impact suffered and whether it might affect crew preferences.

Yes	
No	

11. Are you afraid of contacting a communicable disease or infection on board the ship?
Please, choose only one answer.

Yes	
Probably yes	
I am not sure	
Probably no	
No	

Funded by the European Union

Section 3. Willingness to accept technical solutions to screen for and diagnose early communicable diseases outbreaks.

1. Do you agree with the use of the following technological solutions on board a cruise ship to assist with the early detection of a communicable disease outbreak?
   Please, indicate your preference on every row below.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Cameras detecting passengers with fever					
Wearable devices (e.g., smartwatch) for health monitoring					
Outfitting cabin's sink and toilet with virus sensors					
Outfitting the cabin with air quality sensors					
Air purifier in the cabin and the air conditioning system					
Cabin's and/or public spaces' surfaces coated with antibacterial/antiviral materials					
Cabin's and/or public spaces' TVs used for real-time guidance and advice in cases of disease outbreaks					

2. If you "agree" or "strongly agree" with any of the above solutions, why?
   Please, indicate your preference on every row below.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I am in favor of use of any new technology					
It would safeguard /remove any health-related concerns during the cruise					
Other (please specify)					

3. If you "disagree" or "strongly disagree" with any of the above solutions, why?
Please, indicate your preference on every row below.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I am worried about my health data security					
I am worried of being socially stigmatized in case of illness					
I am worried about the effect it might have on my health (electromagnetic radiation etc.)					
I am worried about feeling uncomfortable during my work on the cruise (it would cause me anxiety)					
I don't want to be monitored					
Other (please specify)					

PASSENGER QUESTIONNAIRE

Introduction

We would like to thank you for participating in this survey. This survey is implemented under the framework of the HS4U project (Healthy Ship For You), which is funded by the European Commission (HORIZON Europe – Grant Agreement 101069937). The purpose of this project is the safe proofing of cruises by integrating the different departments of the cruise ship with technological solutions for early detection of the four most prevalent communicable diseases, namely COVID-19, Influenza, Gastrointestinal diseases, and Legionella.

We kindly ask you to answer every question of this survey as honestly as possible.

The first two sections of the survey enquire after basic sociodemographic characteristics, previous experience with cruising and medical history. The answers are fully anonymized and cannot – in any case - be associated with you, as a person. The Health Policy Institute, which is scientifically responsible for the analysis of responses and the final report, will never collect, acquire access to, store or process non-anonymized data.

The third section of the survey probes into your willingness to adopt several technological solutions for screening and early detection of communicable diseases' outbreaks. These solutions will either be installed in your cabin or at public places of the cruise ship. There are also some solutions, which include wearable devices measuring in real time vital signs of passengers and crew.

By participating in this survey, you provide your consent to the Health Policy Institute to analyse and process your fully anonymized answers for purposes of preparing a scientific publication.

We kindly thank you for your time.

INFORMED CONSENT TO PARTICIPATE IN THE SURVEY

Having read and understood the above, I provide my informed consent for the use of the anonymized data I shall be providing for the purposes of the preparation of a scientific publication.

	Yes	Thank you. You may proceed to the survey questions
	No	Thank you for your time. You may not participate in the survey

Signed:

Dated:

Section 1. Demographic characteristics.

Demographic data is collected to help us understand whether responses to the survey are affected by personal characteristics such as gender, age, or country of residence.

1. What is your gender?
Please, choose only one answer.

Male	
Female	

2. What is your country of residence?
Please indicate the country where you reside.

3. Please insert the year of your birth, using four digits, e.g., 1962

. . . .

4. What is the highest degree you hold or level of education you have completed?
Please, choose only one answer.

Less than a high school degree	
High school degree or equivalent	
College degree	
Bachelor's degree	
Master's or PhD degree	
Other (please specify)	

5. Which of the following categories best describes your employment status?
Please, choose only one answer.

Employed / self-employed	
Unemployed	
Retired	
Disabled, not able to work	
Other (please specify)	

6. What is your marital status?
   Please, choose only one answer.

Not married or not living with a partner, no children	
Not married or not living with a partner, with children	
Married or living with a partner, no children	
Married or living with a partner, with children	
Divorced or separated, no children	
Divorced or separated, with children	
Widowed, no children	
Widowed, with children	
Other (please specify)	

Section 2. Passenger profile.

Profile data will inform our analysis with respect to passenger technological, travel and medical preferences and experiences.

1. How long on average do you use technology daily to perform the following tasks, if at all?
This questions aims at understanding whether the passenger is a frequent technology user.

Task	**Daily hours (on average)**
To perform my work / duties	
To keep up to date with news	
To communicate with friends and family	
To monitor my health vitals / exercise routines / sleep patterns	
For entertainment purposes (social media, subscription platforms etc.)	

2. Have you noticed any health or sanitation safety measures in place on board the ship, particularly for communicable diseases?

Yes	
No	

3. If yes, do you find them adequate and sufficient?
Provide an answer only if your previous answer was "yes".

Yes	
Probably yes	
I am not sure	
Probably no	
No	

4. Is this your first time on a cruise?
This questions aims at understanding whether the passenger is a new traveler or has a pre-set view of the cruise.

Yes	
No	

5. If no, how many times have you been on a cruise to-date?
Please, choose only one answer.

1	
2-3	
More than 3	

6. Have you ever been diagnosed with a chronic condition?
   Please, choose only one answer.
   This question aims to inform correlations with passenger preferences, based on the presence of one or multiple comorbidities.

Yes	
No	

7. If yes, have you ever been hospitalized for this condition?
   This question aims to inform correlations with passenger preferences, based on the severity of their comorbidities.

Yes	
No	

8. Are you familiar with the following communicable diseases?
   You may choose more than one answer.
   This question aims to record current passenger knowledge of the most common communicable diseases on board cruise ships.

	Yes	No
Covid-19		
Influenza		
Gastrointestinal diseases		
Legionella		

9. Have you ever been affected by one of these diseases?
   This question aims to record level of awareness of the impact of these diseases amongst passengers.

Yes	
No	

10. If yes, were you hospitalized?
    This question aims to record severity of impact suffered and whether it might affect passenger preferences.

Yes	
No	

11. Are you afraid of contacting a communicable disease or infection on board the ship?
    Please, choose only one answer.

Yes	
Probably yes	
I am not sure	
Probably no	
No	

Section 3. Willingness to accept technical solutions to screen for and diagnose early communicable diseases' outbreaks.

1. Do you agree with the use of the following technological solutions on board a cruise ship to assist with the early detection of a communicable disease outbreak?
Please, indicate your preference on every row below.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Cameras detecting passengers with fever					
Wearable devices (e.g., smartwatch) for health monitoring					
Outfitting cabin's sink and toilet with virus sensors					
Outfitting the cabin with air quality sensors					
Air purifier in the cabin and the air conditioning system					
Cabin's and/or public spaces' surfaces coated with antibacterial/antiviral materials					
Cabin's and/or public spaces' TVs used for real-time guidance and advice in cases of disease outbreaks					

2. If you "agree" or "strongly agree" with any of the above solutions, why?
Please, indicate your preference on every row below.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I am in favor of use of any new technology					
It would safeguard /remove any health-related concerns during the cruise					
Other (please specify)					

3. If you “disagree” or “strongly disagree” with any of the above solutions, why?
Please, indicate your preference on every row below.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I am worried about my health data security					
I am worried of being socially stigmatized in case of illness					
I am worried about the effect it might have on my health (electromagnetic radiation etc.)					
I am worried about feeling uncomfortable during the cruise (it would cause me anxiety)					
I don’t want to be monitored					
Other (please specify)					

QUESTIONNAIRE DE L'ÉQUIPAGE

Introduction

Nous tenons à vous remercier de participer à cette enquête. Cette enquête est conduite dans le cadre du projet HS4U (Healthy Ship For You – Un bateau sain, pour vous), qui est financé par la Commission européenne (Programme HORIZON Europe – Contrat n°101069937). Le but de ce projet est la sécurité sanitaire à bord des navires de croisière. Il repose sur l'utilisation, au sein de tous les départements des navires de croisière, de nouvelles technologies pour la détection précoce des quatre maladies transmissibles les plus répandues dans les navires de croisière, à savoir le COVID-19, la grippe, la gastro-entérite et la légionellose. Nous vous prions de bien vouloir répondre à toutes les questions de cette enquête aussi honnêtement que possible.

Les deux premières sections de l'enquête portent sur vos caractéristiques sociodémographiques, votre expérience antérieure en croisière et vos antécédents médicaux. Ces données sont collectées pour nous aider à comprendre si les réponses à l'enquête sont affectées par ces caractéristiques personnelles. La troisième section du sondage examine si vous seriez prêt à adopter un ou plusieurs solutions technologiques pour le dépistage et la détection précoce d'épidémies de maladies transmissibles. Ces solutions seraient soit installées dans votre cabine, soit dans les lieux publics du bateau de croisière. Elles pourraient inclure également des appareils portables mesurant en temps réel les signes vitaux des passagers et de l'équipage.

En participant à cette enquête, vous consentez à ce que le Health Policy Institute analyse et traite vos réponses entièrement anonymisées à des fins de préparation d'une publication scientifique. Les réponses sont entièrement anonymisées et ne peuvent en aucun cas vous être personnellement associées à vous, en tant que personne. Le Health Policy Institute, qui est scientifiquement responsable de l'analyse des réponses et de la production du rapport final, ne collectera jamais, ne demandera pas accès, ne stockera ni ne traitera de données non anonymisées.

Nous vous remercions de votre temps.

CONSENTEMENT ÉCLAIRÉ POUR PARTICIPER À L'ENQUÊTE

Après avoir lu et compris ce qui précède, je donne mon consentement éclairé pour l'utilisation des données anonymisées que je fournirai à la préparation d'une publication scientifique.

	Oui	Merci. Vous pouvez passer aux questions du sondage
	Non	Merci pour votre temps. Vous ne pouvez pas participer à l'enquête

Signé:

Date:

Section 1. Caractéristiques démographiques.

Les données démographiques sont collectées pour nous aider à comprendre si les réponses à l'enquête sont affectées par des caractéristiques personnelles telles que le sexe, l'âge ou le pays de résidence.

1. Quel est votre sexe ? (Au moment de la naissance).
   Veuillez ne choisir qu'une seule réponse.

Homme	
Femme	

2. Quel est votre pays de résidence?
   Veuillez indiquer le pays où vous résidez.

3. Merci de fournir votre année de naissance, à quatre chiffres, par exemple, 1962

. . . .

4. Quel est le diplôme le plus élevé que vous détenez ou le niveau d'études que vous avez atteint ?
   Veuillez ne choisir qu'une seule réponse.

Niveau inférieur à un diplôme d'études secondaires	
Diplôme d'études secondaires	
Diplôme universitaire	
Licence	
Master ou Doctorat	
Autre (veuillez préciser)	

Section 2. Profil du personnel d'équipage.

Ces données éclaireront notre analyse en ce qui concerne les préférences et les expériences technologiques, de voyage et médicales de l'équipage.

1. Combien de temps en moyenne utilisez-vous quotidiennement une outil numérique pour effectuer les tâches suivantes?
Ces questions visent à comprendre si le membre d'équipage est un utilisateur fréquent de la technologie.

Tâche	**Heures quotidiennes (en moyenne)**
Pour effectuer votre travail	
Pour suivre l'actualité	
Pour communiquer avec vos amis et votre famille	
Pour surveiller vos signes vitaux de santé / vos routines d'exercice / vos habitudes de sommeil	
Pour vous divertir (réseaux sociaux, plateformes d'abonnement, etc.)	

2. Avez-vous remarqué des mesures de sécurité sanitaires ou sanitaires à bord du navire, notamment vis-à-vis des maladies transmissibles ?

Oui	
Non	

3. Si oui, les trouvez-vous adéquates et suffisantes ?
Ne répondez que si votre réponse précédente était « oui ».

Oui	
Probablement oui	
je ne suis pas sûr	
Probablement pas	
Non	

4. C'est la première fois que vous partez en croisière ?
Ces questions visent à comprendre si c'est la première fois que vous travaillez sur une croisière ou si vous avez déjà été exposé à l'environnement de travail d'une croisière.

Oui	
Non	

5. Si non , combien de croisières avez-vous faites à ce jour ?
Merci de ne choisir qu'une seule réponse.

1	
2-3	
Plus de 3	

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6. Avez-vous déjà été diagnostiqué.e pour une maladie chronique?
   Cette question vise à éclairer les corrélations avec les préférences de l'équipage, en fonction de la présence d'une ou de plusieurs comorbidités.

Oui	
Non	

7. Si oui, avez-vous déjà été hospitalisé.e pour cette maladie?
   Cette question vise à éclairer les corrélations avec les préférences de l'équipage, en fonction de la gravité de leurs comorbidités.

Oui	
Non	

8. Connaissez-vous les maladies transmissibles suivantes ?
   Vous pouvez choisir plus d'une réponse.
   Cette question vise à enregistrer les connaissances actuelles de l'équipage sur les maladies transmissibles les plus courantes à bord des navires de croisière.

	Oui	Non
COVID-19		
Grippe		
Gastro-entérite		
Légionellose		

9. Avez-vous déjà été malade de l'une de ces maladies ?
   Cette question vise à enregistrer le niveau de sensibilisation à l'impact de ces maladies parmi l'équipage.

Oui	
Non	

10. Si oui, avez-vous été hospitalisé.e ?
    Cette question vise à enregistrer la gravité de l'impact subi et si cela pourrait affecter les préférences de l'équipage.

Oui	
Non	

11. Avez-vous peur de contracter une maladie transmissible ou une infection à bord du navire ?
    Veuillez ne choisir qu'une seule réponse.

Oui	
Probablement oui	
Je ne suis pas sûr	
Probablement pas	
Non	

Section 3. Acceptabilité des solutions technologiques pour dépister et diagnostiquer de façon précoce une épidémie.

1. Êtes-vous d'accord avec l'utilisation des solutions technologiques suivantes à bord d'un navire de croisière pour aider à la détection précoce du déclenchement d'une épidémie ?
Veuillez indiquer votre choix sur chaque ligne ci-dessous.

	Tout à fait d'accord	D'accord	Sans avis	Pas d'accord	Pas du tout d'accord
Caméras détectant les passagers fiévreux					
Dispositifs mobiles et prêts à porter (par exemple, smartwatch) pour la surveillance de la santé					
Équiper le lavabo et les toilettes de la cabine d'un système de détection de virus					
Équiper la cabine de capteurs de qualité de l'air					
Purificateur d'air dans la cabine et le système de climatisation					
Surfaces des cabines et/ou des espaces publics recouvertes de matériaux antibactériens/antiviraux					
Téléviseurs des cabines et/ou des espaces publics utilisés pour l'orientation et les conseils en temps réel en cas d'épidémie					

2. Si vous êtes « d'accord » ou « tout à fait d'accord » avec l'une des solutions ci-dessus, pourquoi ?
Veuillez indiquer votre choix sur chaque ligne ci-dessous.

	Tout à fait d'accord	D'accord	Sans avis	Pas d'accord	Pas du tout d'accord
Je suis favorable à l'utilisation de toute nouvelle technologie à cette fin					
Cela protégerait / supprimerait tout problème de santé pendant la croisière					
Autre (veuillez préciser)					

3. Si vous êtes "Pas d'accord" ou "Pas du tout d'accord" avec l'une des solutions ci-dessus, pourquoi ?
Veuillez indiquer votre choix sur chaque ligne ci-dessous.

	Tout à fait d'accord	D'accord	Sans avis	Pas d'accord	Pas du tout d'accord
Je m'inquiète pour la sécurité de mes données de santé					
Je crains d'être socialement stigmatisé en cas de maladie					
Je m'inquiète de l'effet que cela pourrait avoir sur ma santé (rayonnement électromagnétique, etc.)					
J'ai peur de me sentir mal à l'aise pendant la croisière (cela me causerait de l'anxiété)					
Je ne veux pas être surveillé					
Autre (veuillez préciser)					

QUESTIONNAIRE PASSAGERS

Introduction

Nous tenons à vous remercier de participer à cette enquête. Cette enquête est conduite dans le cadre du projet HS4U (Healthy Ship For You – Un bateau sain, pour vous), qui est financé par la Commission européenne (Programme HORIZON Europe – Contrat n°101069937). Le but de ce projet est la sécurité sanitaire à bord des navires de croisière. Il repose sur l'utilisation, au sein de tous les départements des navires de croisière, de nouvelles technologies pour la détection précoce des quatre maladies transmissibles les plus répandues dans les navires de croisière, à savoir le COVID-19, la grippe, la gastro-entérite et la légionellose. Nous vous prions de bien vouloir répondre à toutes les questions de cette enquête aussi honnêtement que possible.

Les deux premières sections de l'enquête portent sur vos caractéristiques sociodémographiques, votre expérience antérieure en croisière et vos antécédents médicaux. Ces données sont collectées pour nous aider à comprendre si les réponses à l'enquête sont affectées par ces caractéristiques personnelles. La troisième section du sondage examine si vous seriez prêt à adopter un ou plusieurs solutions technologiques pour le dépistage et la détection précoce d'épidémies de maladies transmissibles. Ces solutions seraient soit installées dans votre cabine, soit dans les lieux publics du bateau de croisière. Elles pourraient inclure également des appareils portables mesurant en temps réel les signes vitaux des passagers et de l'équipage.

En participant à cette enquête, vous consentez à ce que le Health Policy Institute analyse et traite vos réponses entièrement anonymisées à des fins de préparation d'une publication scientifique. Les réponses sont entièrement anonymisées et ne peuvent en aucun cas vous être personnellement associées à vous, en tant que personne. Le Health Policy Institute, qui est scientifiquement responsable de l'analyse des réponses et de la production du rapport final, ne collectera jamais, ne demandera pas accès, ne stockera ni ne traitera de données non anonymisées.

Nous vous remercions de votre temps.

CONSENTEMENT ÉCLAIRÉ POUR PARTICIPER À L'ENQUÊTE

Après avoir lu et compris ce qui précède, je donne mon consentement éclairé pour l'utilisation des données anonymisées que je fournirai à la préparation d'une publication scientifique.

	Oui	Merci. Vous pouvez passer aux questions du sondage
	Non	Merci pour votre temps. Vous ne pouvez pas participer à l'enquête

Signé:

Date:

Section 1. Caractéristiques démographiques.

Les données démographiques sont collectées pour nous aider à comprendre si les réponses à l'enquête sont affectées par des caractéristiques personnelles telles que le sexe, l'âge ou le pays de résidence.

1. Quel est votre sexe ? (Au moment de la naissance).
Veuillez ne choisir qu'une seule réponse.

Homme	
Femme	

2. Quel est votre pays de résidence?
Veuillez indiquer le pays où vous résidez.

3. Merci de fournir votre année de naissance, à quatre chiffres, par exemple, 1962

. . . .

4. Quel est le diplôme le plus élevé que vous détenez ou le niveau d'études que vous avez atteint ?
Veuillez ne choisir qu'une seule réponse.

Niveau inférieur à un diplôme d'études secondaires	
Diplôme d'études secondaires	
Diplôme universitaire	
Licence	
Master ou Doctorat	
Autre (veuillez préciser)	

5. Laquelle des catégories suivantes décrit le mieux votre statut d'emploi ?
Veuillez ne choisir qu'une seule réponse.

Activité salariée ou indépendente	
Sans emploi	
À la retraite	
En incapacité de travailler	
Autre (veuillez préciser)	

6. Quel est votre état civil?
Veuillez ne choisir qu'une seule réponse.

Non marié ou ne vivant pas en couple, sans enfant	
Non marié ou ne vivant pas en couple, avec enfants	
Marié ou vivant en couple, sans enfant	
Marié ou vivant en couple, avec enfants	

Divorcé ou séparé, sans enfant	
Divorcé ou séparé, avec enfants	
Veuf ou veuve, pas d'enfant	
Veuf ou veuve, avec enfants	
Autre (veuillez préciser)	

Section 2. Profil du passager.

Ces données éclaireront notre analyse en ce qui concerne les préférences et les expériences technologiques, de voyage et médicales des passagers.

1. Combien de temps en moyenne utilisez-vous quotidiennement une outil numérique pour effectuer les tâches suivantes?
   Ces questions visent à comprendre si le passager est un utilisateur fréquent de technologie.

Tâche	**Heures quotidiennes (en moyenne)**
Pour effectuer votre travail	
Pour suivre l'actualité	
Pour communiquer avec vos amis et votre famille	
Pour surveiller vos signes vitaux de santé / vos routines d'exercice / vos habitudes de sommeil	
Pour vous divertir (réseaux sociaux, plateformes d'abonnement, etc.)	

2. Avez-vous remarqué des mesures de sécurité sanitaires ou sanitaires à bord du navire, notamment vis-à-vis des maladies transmissibles ?

Oui	
Non	

3. Si oui, les trouvez-vous adéquates et suffisantes ?
   Ne répondez que si votre réponse précédente était « oui ».

Oui	
Probablement oui	
Je ne suis pas sûr	
Probablement pas	
Non	

4. C'est la première fois que vous partez en croisière ?
Ces questions visent à comprendre si le passager est un nouveau voyageur ou à une vision préétablie des croisières.

Oui	
Non	

5. Si non, combien de croisières avez-vous faites à ce jour ?
Merci de ne choisir qu'une seule réponse.

1	
2-3	
Plus de 3	

6. Avez-vous déjà été diagnostiqué.e pour une maladie chronique?
Veuillez ne choisir qu'une seule réponse.
Cette question vise à éclairer les corrélations avec les préférences des passagers, en fonction de la présence d'une ou de plusieurs comorbidités.

Oui	
Non	

7. Si oui, avez-vous déjà été hospitalisé.e pour cette maladie?
Cette question vise à éclairer les corrélations avec les préférences des passagers, en fonction de la gravité de leurs comorbidités.

Oui	
Non	

8. Connaissez-vous les maladies transmissibles suivantes ?
Vous pouvez choisir plus d'une réponse.
Cette question vise à mesurer les connaissances qu'ont les passagers sur les maladies transmissibles les plus courantes à bord des navires de croisière.

	Oui	Non
COVID-19		
Grippe		
Gastro-entérite		
Légionellose		

9. Avez-vous déjà été malade de l'une de ces maladies ?
Cette question vise à mesurer le niveau de sensibilisation à l'impact de ces maladies parmi les passagers.

Oui	
Non	

10. Si oui, avez-vous été hospitalisé.e ?
Cette question vise à mesurer la gravité de l'impact subi et si cela affecte les préférences des passagers.

Oui	
Non	

11. Avez-vous peur de contracter une maladie transmissible ou une infection à bord du navire ?
Veuillez ne choisir qu'une seule réponse.

Oui	
Probablement oui	
Je ne suis pas sûr	
Probablement pas	
Non	

Section 3. Acceptabilité des solutions technologiques pour dépister et diagnostiquer de façon précoce une épidémie.

1. Êtes-vous d'accord avec l'utilisation des solutions technologiques suivantes à bord d'un navire de croisière pour aider à la détection précoce du déclenchement d'une épidémie ?
Veuillez indiquer votre choix sur chaque ligne ci-dessous.

	Tout à fait d'accord	D'accord	Sans avis	Pas d'accord	Pas du tout d'accord
Caméras détectant les passagers fiévreux					
Dispositifs mobiles et prêts à porter (par exemple, smartwatch) pour la surveillance de la santé					
Équiper le lavabo et les toilettes de la cabine d'un système de détection de virus					
Équiper la cabine de capteurs de qualité de l'air					
Purificateur d'air dans la cabine et le système de climatisation					
Surfaces des cabines et/ou des espaces publics recouvertes de matériaux antibactériens/antiviraux					
Téléviseurs des cabines et/ou des espaces publics utilisés pour l'orientation et les conseils en temps réel en cas d'épidémie					

2. Si vous êtes « d'accord » ou « tout à fait d'accord » avec l'une des solutions ci-dessus, pourquoi ?
Veuillez indiquer votre choix sur chaque ligne ci-dessous.

	Tout à fait d'accord	D'accord	Sans avis	Pas d'accord	Pas du tout d'accord
Je suis favorable à l'utilisation de toute nouvelle technologie à cette fin					
Cela protégerait / supprimerait tout problème de santé pendant la croisière					
Autre (veuillez préciser)					

3. Si vous êtes "Pas d'accord" ou "Pas du tout d'accord" avec l'une des solutions ci-dessus, pourquoi ?
   Veuillez indiquer votre choix sur chaque ligne ci-dessous.

	Tout à fait d'accord	D'accord	Sans avis	Pas d'accord	Pas du tout d'accord
Je m'inquiète pour la sécurité de mes données de santé					
Je crains d'être socialement stigmatisé en cas de maladie					
Je m'inquiète de l'effet que cela pourrait avoir sur ma santé (rayonnement électromagnétique, etc.)					
J'ai peur de me sentir mal à l'aise pendant la croisière (cela me causerait de l'anxiété)					
Je ne veux pas être surveillé					
Autre (veuillez préciser)					

ANNEX 3 – Instructions Note

INSTRUCTIONS COVER NOTE

This is an instructions' note to support you with implementing the study protocol for the "Stated preference surveys amongst passengers and crew on willingness to adopt proposed technical solutions for screening and early diagnosis of communicable diseases on board cruise ships" that (CRUISE PARTNER NAME) is facilitating as part of its participation in the HS4U project (Healthy Ship For You), which is funded by the European Commission (HORIZON Europe – Grant Agreement 101069937).

- The instructions note must be read thoroughly by everybody whom the information herein concerns, and the instructions must be exactly followed**.**
- Data collection is the responsibility of the cruise partners.
- On designated cruises (you will be informed which by CRUISE PARTNER NAME MANAGER) paper questionnaires titled "**PASSENGER QUESTIONNAIRES**" will have to be handed for completion to every **4th passenger** boarding the ship and checking in at reception.
- Reception staff will use the following (indicative) short text to ask the designated passenger to complete the questionnaire:
- *"This is a very short, anonymized, questionnaire that is assisting us with the future safe proofing of cruises through enhancing the screening and early detection capability of cruise ships regarding the four most prevalent communicable diseases on board ships. This survey is part of a European Commission funded project – the HS4U – of which we are partners. May we kindly ask you to fill in this very short questionnaire, completely anonymously? If you would agree and return the completed questionnaire to us before reaching our final port, we would be happy to extend you a voucher for a free drink at the bar, as a thank you for your contribution".*
- Reception staff will then inquire after the language in which the patient feels most comfortable completing the questionnaire (English, French, Greek).
- Reception staff will hand the paper questionnaire in the preferred language to the designated passenger.
- Upon receiving the completed questionnaires, Reception staff will store them safely in a designated cupboard in the reception space.
- Upon reaching the final port and docking, the total of completed **PASSENGER QUESTIONNAIRES** will be handed to (NAME OF DESIGNATED ADMINISTRATIVE PERSON from CRUISE PARTNER NAME).
- With regards to "**CREW QUESTIONNAIRES**", **ALL** crew members will be handed a questionnaire for completion upon embarkation.

- **ALL** crew members will be asked to fill in the questionnaire and return to Reception prior to disembarkation.
- Reception staff will inquire after the language in which the crew feels most comfortable completing the questionnaire (English, French, Greek) and hand the relevant questionnaire for completion.
- Reception staff will follow the process detailed above on receiving, storing, and handing in the completed questionnaires upon disembarkation.

For further inquiries or assistance, please contact …….. (DETAILS OF DESIGNATED ADMINISTRATIVE PERSON from CRUISE PARTNER NAME)

ANNEX 4 – Minutes of 2nd Workshop with external partners

SUMMARY

This document summarizes the discussion during the external workshop that took place on the 22nd of May 2023, among the partners involved in Task 2.1 of WP2. It is described in the Grant Agreement as the 2nd Workshop with external partners and it was conducted via the Zoom platform. The main goal of this meeting was to validate the methodology and discuss on the results and key findings of the subtasks accomplished within Task 2.1.

LIST OF PARTICIPANTS

	NAME	COMPANY
1	Christina Golna	HPI
2	Ioannis Markakis	HPI
3	Pavlos Golnas	HPI
4	Panagiotis Evangelou	NTUA
5	Yvonni Damianidou	ABS
6	Dimitrios Lyridis	NTUA
7	Anna Kontini	AETHON
8	Vladimir Gershanik	EEAB

AGENDA

EVENT	**2nd Workshop with external partners**
DATE	22.05.2023
PLACE	Online

HS4U – 2nd Workshop with members of the External Advisory Board	
Meeting Schedule	**Agenda**
13:00 – 13:05	Welcome – Adoption of the agenda – Workshop objectives. *Christina Golna, Workshop Coordinator*
13:05 – 13:30	Presentation of the tasks performed in Deliverable 2.1 - Systematic Literature Review - 1st Workshop with internal stakeholders - 2 Stated Preference Surveys amongst passengers and crew *Ioannis Markakis, Health Policy Institute*
13:30 – 14:00	Feedback from members of the External Advisory Board. *All*

MINUTES

Several days before the workshop a doodle poll was contacted, and the members of the External Experts Advisory Board were invited to submit their preferred date for the Workshop to be organized. Three members of the EEAB joined the doodle poll and the meeting was decided to take place on Monday 22nd of May. The Workshop's agenda and a draft version of Deliverable 2.1 ("Mappings of existing framework conditions, challenges, system failures and gap analysis") were sent to the participants via email. The partners and members of EEAB who participated at the Workshop were urged to read those documents prior to the meeting, to increase the workshop's productivity. The only person from the EEAB who joined the meeting was Professor Vladimir Gershanik.

At the beginning of the workshop, Christina Golna (HPI) welcomed the participants, presented the meeting's agenda and the workshop's goals and objectives. The main task of the workshop was the review of the methodology described in D2.1 and the discussion of the results and key findings of the stated preference surveys. As an introduction she presented the WP2 objectives and the research questions throughout Task 2.1. Moreover, she briefly outlined the subtasks which had been accomplished for the completion of the deliverable. Ioannis Markakis (HPI) took the floor next, who presented in detail the workflow of Task 2.1. At first, he presented the methodology of the systematic literature review (SLR) of the most prevalent communicable diseases on board cruise ships, and the mapping of EU and international guidelines on prevention, screening, diagnosis, and containment of these diseases onboard cruise ships. The outcome of the SLR was to confirm that the most prevalent and important diseases on board cruise ships are COVID-19, influenza, gastrointestinal infections, and legionnaire's disease. With regards to the guidelines and recommendations aimed at addressing these, the SLR confirmed that despite screening and early identification being cardinal in prompt diagnosis and effective risk mitigation, both of which are extensively presented as goals of public health interventions on board cruise ships, there appears to be limited reference to tools and methods to perform large scale screening and early identification amongst passengers and crew on board cruise ship. Such interventions would probably necessitate use of wearables or other biosensing devices that are to-date not included in the relevant literature.

Subsequently, he presented in brief the discussion and outcomes of the 1st Workshop with internal stakeholders. The workshop's objectives were the validation of the practice gap identified by the SLR and the presentation to the cruise partners of several technological solutions to address this gap. The consortium partners validated the findings of the SLR, selected COVID-19 and Norovirus as the main diseases of concern and ranked the technological solutions which would be included in the willingness questionnaires.

The results of this workshop were considered as input for the two stated preference surveys amongst passengers and crew on willingness to adopt the proposed technological solutions. Ioannis Markakis explained the design process of the questionnaires, the validity check and instrument construction, the procedures for data management, the description and structure of the questionnaires and the ethics approval application.

He then continued with showing the results of the surveys. At first, he explained the test-retest procedure which ensured the questionnaires' reliability. Next, he presented the survey's identification and the sociodemographic characteristics of the participants. The description of the participants' profile came up next, with regards to their technological habits, their cruise experience, their knowledge of communicable diseases and their medical history. Consequently, he described the acceptance of each technological solution by the passengers and crew, the reasons why the participants either agreed or disagreed with these solutions and the correlations among the willingness and the various sociodemographic characteristics of the participants. Closing his presentation, he asked Professor Vladimir Gershanik (EEAB) to provide his comments concerning the process and deliverables of Task 2.1.

Professor Vladimir Gershanik appreciated the scientific approach of every part of the deliverable. He commented that from his point of view the statistical results are valid and they can be useful for the progress of the project. He also mentioned that the systematic literature review was complete, and he urged HPI to publish the results and discussion of the two surveys.

Panos Evangelou (NTUA), who is the leader of WP2 wrapped up the meeting, thanking Professor Gershanik for attending the Workshop and mentioning that the final deliverable will meet the proposal's requirements and will help with the implementation of the project.

COMMENTS, ACTION LIST AND AGREEMENT

Critical action points that were discussed during the kick-off meeting are presented in a tabular form below.

	CONTENT	PARTNER(S) IN CHARGE	DEADLINE	STATUS
1	HPI will prepare the Minutes of the workshop and validate them with the participants of the meeting. Next, they will be shared with the rest of the consortium.	HPI	25/05/2023	OPEN
2	HPI will finalize deliverable D2.1.	HPI	30/05/2023	OPEN

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PRESENTATIONS DURING THE WORKSHOP

PRESENTATION "MAPPINGS OF EXISTING FRAMEWORK CONDITIONS, CHALLENGES, SYSTEM FAILURES AND GAP ANALYSIS"

Presented by Christina Golna (HPI) and Ioannis-Anestis Markakis (HPI)

Update on D2.1 Mappings of existing framework conditions, challenges, system failures and gap analysis

WP2: HS4U Project Requirements' Elicitation and Architecture

John Markakis, PhD, The Health Policy Institute

DATE: 24 April 2023

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Workshop Objectives

Prior to the meeting a draft version of Deliverable 2.1 "*Mappings of existing framework conditions, challenges, system failures and gap analysis*" was sent to the participants

Main task

Review and discuss the methodology and key findings of D2.1. based on your expert knowledge

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WP2 Objectives

- Highlight existing framework conditions, understanding the ecosystem of cross-sectoral points of system failure (gap analysis and mitigating challenges)
- Identify risks and innovation readiness in the cruise industry and preparedness for change
- Identify best practices, methods and tools including critical updates on technological advancements during the process of the HS4U project delivery
- Develop scenaria for the operation of the CDF and the HS4U architecture, e) utilizing participatory methods

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Research Questions

- What are the most prevalent communicable diseases on board cruise ships?
- How are these managed **across the public heath continuum** (prevention, screening and diagnosis and risk mitigation) and **the journey timeline** (before embarkation, on board the ship, prior or during disembarkation)?
- Is there any gap in their management according to current guidelines and recommendations versus what may be considered state of the art?
- What are the state-of-the-art solutions that can address this gap?
- How willing are passengers and crew to endorse / implement/follow these solutions? What are their preferences?

Expected deliverable

Specific list of state-of-the-art solutions to elevate required public health readiness on board cruise ships, for which there is a stated passenger and crew preference

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Tasks

- **Systematic Literature Review**

  Guidelines, Recommendations, Technological solutions, Prevalent communicable diseases

- **Workshop with internal stakeholders**

  Cruise partners, Technological partners, Validation of the SLR's findings

- **Survey**

  Stated preference surveys, Passengers and Crew, Willingness to adopt technological solutions

- **Report**

  Presentation of the methodology and analysis of the Survey's findings

- **Workshop with external stakeholders**

  Review, Comments, Validation of the methodology and findings of D2.1

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SLR Methodology

- Our search approach included defining several core keywords that were used to form the main search algorithm and screen resulting articles. These were the following:

cruise ship	health threat	disease	communicable disease	outbreak
prevalence	epidemiology	indicator	index	measure
management	mitigation	mitigation plan	emergency treatment	treatment

- The final form of the main algorithm used in the official data sources was:

(health threat *or* ***communicable disease*** *or* ***disease*** *or* ***epidemic*** *or* ***outbreak)*** *and* ***(cruise ship*** *or* ***cruise*** *or* ***cruise ship*** *or* ***ship*** *or* ***on dock)*** *and* ***(prevalence*** *or* ***frequency*** *or* ***indicator*** *or* ***index*** *or* ***measure*** *or* ***rate).***

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Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Studies from 2015 to-date (8 years)	Studies prior to 2015
Observational studies and randomized trials, reviews, systematic reviews, and meta-analyses	Purely laboratory work-experiments (not tested in the field)
Human objects	Animals
English or Greek	Other languages
Available full text	Not available full text

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SLR PRISMA

Identification

- Articles from Databases (n=9,881)*
- Online documents (n=52)

- Duplicate articles removed before screening (n=8,435)
- Duplicate online documents removed before screening (n=3)
- Articles removed upon cross-checking inclusion/exclusion criteria (n=25)

Screening

- Articles screened by title (n=1,421)
- Online documents (n=49)

- Articles excluded (n=528)
- Online documents excluded (n=26)

- Articles screened by abstract (n=893)

- Articles excluded (n=779)

- Articles screened by full text (n=114)

- Articles excluded (n=19)

Included

- Articles (n=95)
- Online documents (n=23)

* Articles break down: 1352 Pubmed, 138 Scopus, 91 Cochrane Library, 8300 Google Scholar

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Results

- Communicable diseases with highest frequency and public health burden on cruise ships:
    - COVID-19 (34/95)
    - Influenza (9/95)
    - Gastrointestinal infections (9/95)
    - Legionella (4/95)

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Results

- For each of the 4 conditions we have mapped (as available):
  - Prevalence / incidence
  - Positive tests/population tested
  - Asymptomatic individuals/total population
  - Attack rate
  - Basic reproduction number
  - Risk Ratio
  - Odds Ration (probability of outbreak)
  - % Of cases on board cruise ships/total cases
  - % Of deaths on board cruise ships/total deaths
  - Hospitalization rate
  - % of deaths/hospitalizations
  - % deaths/positive tests
  - Mortality rate
  - Case Fatality Ratio

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Results

We then mapped all available international and EU guidelines on their management on a public health continuum

Prevention
How to prevent incidence

Screening and Early Detection
How to identify early

Risk Containment/mitigation
How to stop spreading

Other
Surveillance
Reporting

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Results

For each pillar of the public health continuum, we mapped guidelines according to the phase of the travel to which they referred:

1. Before or upon embarkation
2. On board the ship (during travel)
3. Prior to or upon disembarkation

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Discussion

- As regards **prevention**, our SLR confirms an array of recommendations and guidelines that cover most instances and events both before embarkation and during travel and disembarkation of passengers from cruise ships.

- Equally, the SLR attests to extensive guidelines and recommendations on **mitigating the risk** of further contagion as a core component of an integrated public health strategy on board cruise ships.

- Additionally, the SLR confirmed the **diagnosis of cases** on board the ship is also well detailed in the literature of guidelines and recommendations.

- **On the contrary, screening and early identification** of communicable diseases on board the ship is less extensively detailed in guidelines and recommendations, despite the importance attached to the early identification as a prerequisite for risk mitigation.

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Conclusion

The review of these recommendations confirmed that prevention and risk mitigation are exhaustively addressed in the current literature. Diagnosis is also adequately detailed, referring to availability and accessibility of diagnostic means and resources.

Conversely, despite screening and early identification being cardinal in prompt diagnosis and effective risk mitigation, both of which are extensively presented as goals of public health interventions on board cruise ships, there appears to be **limited reference to tools and methods to perform large scale screening and early identification amongst passengers and crew on board cruise ship.**

Such interventions would probably necessitate use of wearables or other biosensing devices that are to-date not included in the relevant literature.

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How to move forward?

- **What are the state-of-the-art solutions that can address this gap?**
  - Workshop with internal partners – CEL and Columbia Blue to validate SLR and agree on state-of-the-art solutions required
  - Workshop with additional stakeholders – to gather insights on state-of-the-art solutions
  - List of state-of-the-art solutions that could be tested with passengers and crew
- **How willing are passengers and crew to endorse / implement/follow these solutions? What are their preferences?**
  - Stated preference survey with passengers – to measure preference for and willingness to endorse/follow proposed state-of-the-art solutions and to define barriers / concerns that would need to be addressed
  - Stated preference survey with crew – to measure preference for and willingness to endorse / implement proposed state-of-the-art solutions and to define barriers / concerns that need to be addressed
  - Both surveys in collaboration with CEL and Columbia Blue, fully anonymized, during cruises

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Tasks

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General info

The Workshop was organized on January 9th 2023.

Its duration was almost 2 ½ hours.

It was held via the Zoom platform.

12 participants from 8 consortium partners.

“Mixed” Workshop WP2 and WP3

LIST OF PARTICIPANTS

	NAME	COMPANY
1	Christina Golna	HPI
2	Ioannis Markakis	HPI
3	Pavlos Golnas	HPI
4	Panagiotis Evangelou	NTUA
5	Paolo Franceschini	VAR
6	Bérengère Lebental	UNI EIFFEL
7	Kaitlyn West	COLUMBIA
8	Anna Kontini	AETHON
9	Pambos Skapoullis	CELESTYAL
10	Miguel Pacheco	UNPARALLEL
11	Andreas M.Papachristoforou	CELESTYAL
12	Bruno Almeida	UNPARALLEL

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Main Goal

Prior to the meeting a draft version of Deliverable 2.1 “*Mappings of existing framework conditions, challenges, system failures and gap analysis*” was sent to the participants

Two Goals:

1. Validation of the practice gap identified by Systematic Literature Review in screening and early detection of the most prevalent communicable diseases during a cruise,
2. Present to the cruise partners the technological solutions that may be considered to address this gap.

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Workshop Agenda

4 Questions:

1. Are there any other practices or measures implemented in your cruise ships **for screening and early detection** not referred to in the SLR?
2. What is the most critical disease to detect?
3. Which of the technological solutions would you be willing to implement in your operations? **Ranking of solutions**.
4. Is there any other (technological) solution except the ones presented which you would expect this project to bring forward and implement?

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Workflow

Are there any other practices or measures implemented in your cruise ships for screening and early detection not referred to in the SLR?

(CELESTYAL) Encourage their passengers to visit the doctor of the ship in case they have symptoms of communicable diseases.
In such cases the doctor's visit should be free of charge.
Participants confirmed:

- All other guidelines referred to the SLR were valid and
- There is a practice gap in screening and early detection that should be the target of the project

What is the most critical disease to detect?

1. Main disease of concern is **COVID-19**
2. The project should also focus on **Norovirus** (big impact on ship companies)

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Workflow

Ranking of technological solutions to be included in the questionnaire

1. **A smart wearable** to report the health-related parameters
2. **Sink / toilet outfitted with biosensors** for COVID / Norovirus
3. **Mobile application** installed on passenger's mobiles for symptom tracking
4. **Air quality monitoring** applications in cabins
5. **Coating of cabin furniture** with anti-bacterial material
6. **Large screens installation** with information and recommendations in case of symptoms

Are there any other technological solutions which should be included in HS4U?

We should combine technology with other procedures and guidelines of the cruise ship. i.e. encouragement to visit the ship's doctor once the symptoms have been verified (from a biosensing device)

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Tasks

- **Systematic Literature Review**

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Stated preference surveys amongst passengers and crew on willingness to adopt proposed technical solutions for screening and early diagnosis of communicable diseases on board cruise ships

- This was a cross-sectional study to **assess the preferences for and willingness of passengers and crew to endorse / implement technical state of the art solutions proposed by HS4U for the screening for and early detection of communicable diseases on board cruise ships.**
- Additional objectives were:
- To record **barriers / concerns of passengers and crew** that impact on their decision to endorse / implement technical state of the art solutions proposed by HS4U for the screening and early detection of communicable diseases.
- **To correlate willingness and barriers / concerns of passengers and crew with their sociodemographic and baseline health status characteristics.**

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Study design

Instrument design

State of the art technological solutions that we agreed with WP3 to survey:

1. Imaging devices,
2. Biosensors in sinks and toilets,
3. Biosensors in HVAC systems for air quality,
4. Antibacterial materials on cabins' surfaces,
5. Large monitors in public places with real time guidance in case of a disease outbreak
6. Daily visits to doctor's office

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Study design

Instrument construction and content validity

- A 4-member committee (Dr. Berengère Lebental, Ms. Anna Kontini, Mr. Panagiotis Evangelou and Mr. Pambos Skapoullis.) evaluated the overall format and items of the questionnaire
- **Each member assessed the relevance of each question in the instrument** and rated the relevance of each question/item in the questionnaire on a scale of 1 to 4.

No of question	1=not relevant	2=somewhat relevant	3=quite relevant	4=very relevant
Question No 1	1	2	3	4
Question No 2	1	2	3	4
Question No 3	1	2	3	4
Question No 4	1	2	3	4
Question No 5	1	2	3	4
Question No 6	1	2	3	4
Question No 7	1	2	3	4
Question No 8	1	2	3	4
Question No 9	1	2	3	4
Question No 10	1	2	3	4
Question No 11	1	2	3	4
Question No 12	1	2	3	4
Question No 13	1	2	3	4
Question No 14	1	2	3	4
Question No 15	1	2	3	4
Question No 16	1	2	3	4
Question No 17	1	2	3	4
Question No 18	1	2	3	4
Question No 19	1	2	3	4
Question No 20	1	2	3	4
Question No 21	1	2	3	4

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Validation process

Instrument construction and content validity

- The content of the questionnaire changed according to the suggestions of the committee.
- A couple of questions were removed (income and marital status of the crew, passenger’s ethnicity) and others were rephrased.
- Acceptance of the suggestion to translate the questionnaire in two other languages (Greek and French) – reduced the exclusion criteria

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Study population and procedures

Selection of subject

- Number of passengers: 350
  - 1 every 4 passengers
- Number of crew: 200
  - All the members of the crew

Selection criteria

- Adults aged ≥18 years old,
- Able and willing to sign the informed consent form,
- Able to read and write in English or in Greek or in French

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Data Management

- Data collection was the responsibility of the cruise partners, in collaboration with the Health Policy Institute, and accurate documentation was the sole responsibility of the Health Policy Institute.
- **In order to ensure a representative sample, a paper questionnaire was handed for completion to every 4th passenger boarding the cruise**
- The completed paper questionnaires were safely stored on board cruise ships, returned to designated cruise / administrative staff upon disembarkation and, thereafter, handed to Health Policy Institute designed researchers for digitization.
- An Instructions cover note about the distribution of the questionnaires to the passengers and crew was provided to cruise partners.
- **The instructions cover note should be read thoroughly by everybody whom the information therein concerns, and the instructions should be exactly followed.**

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Participant informed consent - Questionnaire

ANNEX 1 – PASSENGER QUESTIONNAIRE

PASSENGER QUESTIONNAIRE

Introduction

We would like to thank you for participating in this survey. This survey is implemented under the framework of the HS4U project (Healthy Ship For You), which is funded by the European Commission (HORIZON Europe). The purpose of this project is the safe proofing of cruises by integrating the different departments of the cruise ship with technological solutions for early detection of the four most prevalent communicable diseases, namely COVID-19, Influenza, Norovirus and Legionella.

We kindly ask you to answer every question of this survey as honestly as possible.

The first two sections of the survey enquire after basic sociodemographic characteristics, previous experience with cruising and medical history. The answers are fully anonymized and cannot – in any case - be associated with you, as a person. The Health Policy Institute, which is scientifically responsible for the analysis of responses and the final report, will never collect, acquire access to, store or process non-anonymized data.

The third section of the survey probes into your willingness to adopt several technological solutions for screening and early detection of communicable diseases' outbreaks. These solutions will either be installed in your cabin or at public places of the cruise ship. There are also some solutions, which include wearable devices measuring in real time vital signs of passengers and crew.

By participating in this survey, you provide your consent to the Health Policy Institute to analyse and process your fully anonymized answers for purposes of preparing a scientific publication.

We kindly thank you for your time.

INFORMED CONSENT TO PARTICIPATE IN THE SURVEY

Having read and understood the above, I provide my informed consent for the use of the anonymized data I shall be providing for the purposes of the preparation of a scientific publication.

	Yes	Thank you. You may proceed to the survey questions
	No	Thank you for your time. You may not participate in the survey

Signed:

Dated:

Section 1. Demographic characteristics.

Demographic data is collected to help us understand whether responses to the survey are affected by personal characteristics such as gender, age, or ethnicity.

1. What is your gender? (At time of birth).
Please, choose only one answer.

Male	
Female	

2. What is your ethnicity?
Please, choose only one answer.

American Indian or Alaskan Native	
Asian / Pacific Islander	
Black or African American	
Hispanic or Latino/a	
White / Caucasian	
Multiple ethnicity/ Other (please specify)	

3. What is your age? (Please fill in the year of your birth, using four digits, e.g., 1962)

. . . .

4. What is the highest degree you hold or level of education you have completed?
Please, choose only one answer.

Less than a high school degree	
High school degree or equivalent	
College degree	
Bachelor's degree	
Master's or PhD degree	
Other (please specify)	

5. Which of the following categories best describes your employment status?
Please, choose only one answer.

Employed / self-employed	
Unemployed	
Retired	
Disabled, not able to work	
Other (please specify)	

Section 3. Willingness to accept technical solutions to screen for and diagnose early communicable diseases' outbreaks.

19. Do you agree with the use of the following technological solutions on board a cruise ship to assist with the early detection of a communicable disease outbreak?
Please, select the answer that best suits you in every row.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Imaging devices, such as thermal cameras					
Wearable devices, such as a smartwatch or a smart band					
Outfitted biosensors in the cabin's sink and toilet					
Air quality sensors in the air conditioning (HVAC) system					
Cabin's and/or public spaces' surfaces coated with antibacterial materials					
Cabin's and/or public spaces' TVs used for real-time guidance and advice in cases of disease outbreaks					

20. If you "agree" or "strongly agree" with any of the above solutions, why?
Please, select the answer that best suits you in every row.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I am in favor of use of any new technology					
It would safeguard /remove any health-related concerns during the cruise					
Other (please specify)					

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Instructions note

- An instructions note was handed to the administrative person of the cruise partner.
- Instructions how to
  - perform the survey
  - Store the data
  - Hand them back to HPI for analysis

INSTRUCTIONS NOTE

This is an instructions' note to support you with implementing the study protocol for the "Stated preference surveys amongst passengers and crew on willingness to adopt proposed technical solutions for screening and early diagnosis of communicable diseases on board cruise ships" that (CRUISE PARTNER NAME) is facilitating as part of its participation in the HS4U project (Healthy Ship For You), which is funded by the European Commission (HORIZON Europe – Grant Agreement 101069937).

- The instructions note must be read thoroughly by everybody whom the information herein concerns, and the instructions must be exactly followed.
- Data collection is the responsibility of the cruise partners.
- On designated cruises (you will be informed which by CRUISE PARTNER NAME MANAGER) paper questionnaires titled "**PASSENGER QUESTIONNAIRES**" will have to be handed for completion to every **4th passenger** boarding the ship and checking in at reception.
- Reception staff will use the following (indicative) short text to ask the designated passenger to complete the questionnaire:

  "This is a very short, anonymized, questionnaire that is assisting us with the future safe proofing of cruises through enhancing the screening and early detection capability of cruise ships regarding the four most prevalent communicable diseases on board ships. This survey is part of a European Commission funded project – the HS4U – of which we are partners. May we kindly ask you to fill in this very short questionnaire, completely anonymously? If you would agree and return the completed questionnaire to us before reaching our final port, we would be happy to extend you a voucher for a free drink at the bar, as a thank you for your contribution".
- Reception staff will then inquire after the language in which the patient feels most comfortable completing the questionnaire (English, French, Greek).
- Reception staff will hand the paper questionnaire in the preferred language to the designated passenger.
- Upon receiving the completed questionnaires, Reception staff will store them safely in a designated cupboard in the reception space.
- Upon reaching the final port and docking, the total of completed **PASSENGER QUESTIONNAIRES** will be handed to (NAME OF DESIGNATED ADMINISTRATIVE PERSON from CRUISE PARTNER NAME).
- With regards to "**CREW QUESTIONNAIRES**", **ALL** crew members will be handed a questionnaire for completion upon embarkation.
- **ALL** crew members will be asked to fill in the questionnaire and return to Reception prior to disembarkation.
- Reception staff will inquire after the language in which the crew feels most comfortable completing the questionnaire (English, French, Greek) and hand the relevant questionnaire for completion.

- Reception staff will follow the process detailed above on receiving, storing, and handing in the completed questionnaires upon disembarkation.

For further inquiries or assistance, please contact …___ (DETAILS OF DESIGNATED ADMINISTRATIVE PERSON from CRUISE PARTNER NAME)

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ABS AETHON ENGINEERING HYDRUS GLOBAL SERVICES HYDRUS ENGINEERING EXCELLENCE UNIVERSITY of NICOSIA Epsilon Université Gustave Eiffel LDRA GROUP HPI HEALTH POLICY INSTITUTE Variance Ascola Economic and Financial Consulting RWO CELESTYAL CRUISES UNPARALLEL ECO SENSE COLUMBIA blue The Leisure Group ΝΑΥΠΗΓΕΙΟ ΤΣΙΚΗΣ ERGMASIN DEALS P.C WHITE netcompany intrasoft UNIVERSITY OF CAMBRIDGE
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Questionnaire

Description

The questionnaire was divided in three sections:

- **1st section: Demographic characteristics**

  6 questions for passengers – 4 questions for crew

  Anonymized demographic data was collected to help us understand whether responses to the survey are affected by personal characteristics such as gender, age, or ethnicity

- **2nd section: Passenger - crew profile**

  11 questions for both groups

  Profile data informed our analysis with respect to each group technological, travel and medical preferences and experiences

- **3rd section: Willingness to accept technological solutions**

  3 questions for both groups in tabular (multi columns) forms

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Ethics Board Committee

- Application to Ethics Board Committee
- 5 Sections:
  - Section A – Applicant details and Research summary
  - Section B – Data collection campaign details
  - Section C – Research involving human participants
  - Section D – Personal data protection
  - Section E – Ethics consideration

Annex 2: Application to the Ethics Board

This application must be filled in by the responsible partner/applicant conducting research involving human participants. It aims to serve as a checklist reminding the researcher to take into account all relevant ethical aspects before conducting any experiment within HS4U and to provide the Ethics Board with all the relevant information regarding the data collection campaign or the research involving human participants. The questionnaire itself is divided into different subsections.

SECTION A: Applicant details and Research summary
Name of the applicant (Task leader): John Markakis, PhD **Email address:** jm@healthpolicyinstitute.eu **Organisation:** Health Policy Institute
Additional applicant(s): **Name:** **Organisation Name:** **Email:**

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Results

Reliability of the questionnaire

Test-retest procedure was conducted in 25 participants and its results showed significant agreement and satisfied reliability.

Kappa coefficients ranged from 0.78 to 0.90

and ICCs ranges from 0.80 to 0.92, $p<0.001$

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Results

Survey identification

616 participants:
280 crew members (45.5%)
336 passengers (54.5%)

CREW Demographic Characteristics		Number	Percentage (%)
Gender	Male	210	75.0
	Female	70	25.0
Age (mean, SD)	37.5 (11.6)		
Highest degree of education	Less than high school degree	13	4.6
	High school degree or equivalent	80	28.6
	College degree	118	42.1
	Bachelor's degree	60	21.4
	Master's or PhD degree	9	3.2

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Results

PASSENGERS Demographic Characteristics		Number	Percentage (%)
Gender	Male	131	39.0
	Female	205	61.0
Age (mean, SD)	59.1 (14.2)		
Highest degree of education	Less than high school degree	18	5.4
	High school degree or equivalent	44	13.1
	College degree	66	19.6
	Bachelor's degree	118	35.1
	Master's or PhD degree	89	26.5
Employment status	Employed/ self employed	176	52.4
	Unemployed	18	5.4
	Retired	139	41.4
	Disabled, not able to work	1	0.3
	Other	2	0.6

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Results

PASSENGERS Demographic Characteristics		Number	Percentage (%)
Marital status	Not married or not living with a partner, no children	47	14.0
	Not married or not living with a partner, with children	9	2.7
	Married or living with a partner, no children	98	29.2
	Married or living with a partner, with children	120	35.7
	Divorced or separated, no children	8	2.4
	Divorced or separated, with children	22	6.5
	Widowed, no children	4	1.2
	Widowed, with children	27	8.0
	Other	1	0.3

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Results

Crew and Passenger profile

How long on average do you use technology daily to perform the following tasks?	Crew N=280		Passengers N=336	
	Mean (SD)	**Median (IQR)**	**Mean (SD)**	**Median (IQR)**
To perform my work/duties	8.5 (3.6)	10 (10 – 10)	4.32 (2.8)	4 (4 – 4)
To keep up to date with news	0.74 (1.31)	0.5 (0.5 – 0.5)	1.16 (0.73)	1 (1 – 1)
To communicate with friends and family	1.2 (0.82)	1 (1 – 1)	1.33 (0.9)	1 (1 – 1)
To monitor my health vitals/ exercise routines/sleep patterns	1.29 (2.59)	0.5 (0.5 – 0.5)	0.81 (2.34)	0.5 (0.5 – 0.5)
For entertainment purposes (social media, subscription platforms etc.)	1.17 (0.94)	1 (1 – 1)	1.52 (1.47)	1 (1 – 2)

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Results

Crew and Passenger profile

Information on cruise experience		Crew N=280		Passengers N=336	
	Response	**Number**	**(%)**	**Number**	**(%)**
Have you noticed any health or sanitation safety measures in place on board the ship, particularly for communicable diseases?	**No**	73	26.1	87	25.9
	Yes	207	73.9	249	74.1
If yes, do you find them adequate and sufficient?	**Yes**	159	77.9	154	61.8
	Probably yes	33	16.2	71	28.5
	I am not sure	11	5.4	15	6.0
	Probably no	0	0.0	7	2.8
	No	1	0.5	2	0.8

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Results

Crew and Passenger profile

Information on cruise experience	Response	Crew N=280 Number	Crew N=280 (%)	Passengers N=336 Number	Passengers N=336 (%)
Is this the first time been (or have worked) on a cruise ship?	**No**	218	77.9	213	63.4
	Yes	62	22.1	123	36.6
If no, how many times have you been or worked on a cruise ship to-date?	**1**	11	5.1	24	11.4
	2-3	40	18.6	79	37.4
	More than 3	164	76.3	108	51.2

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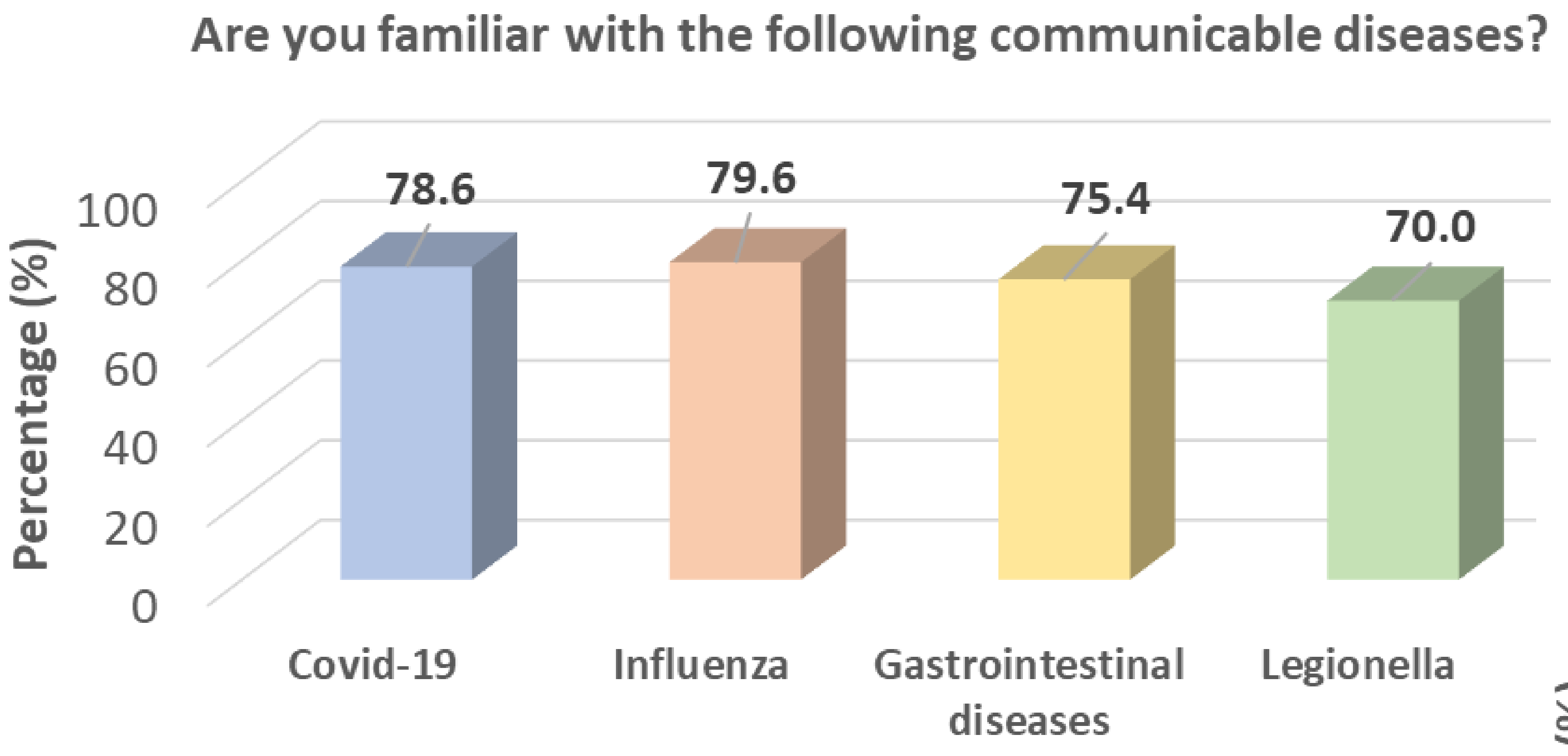
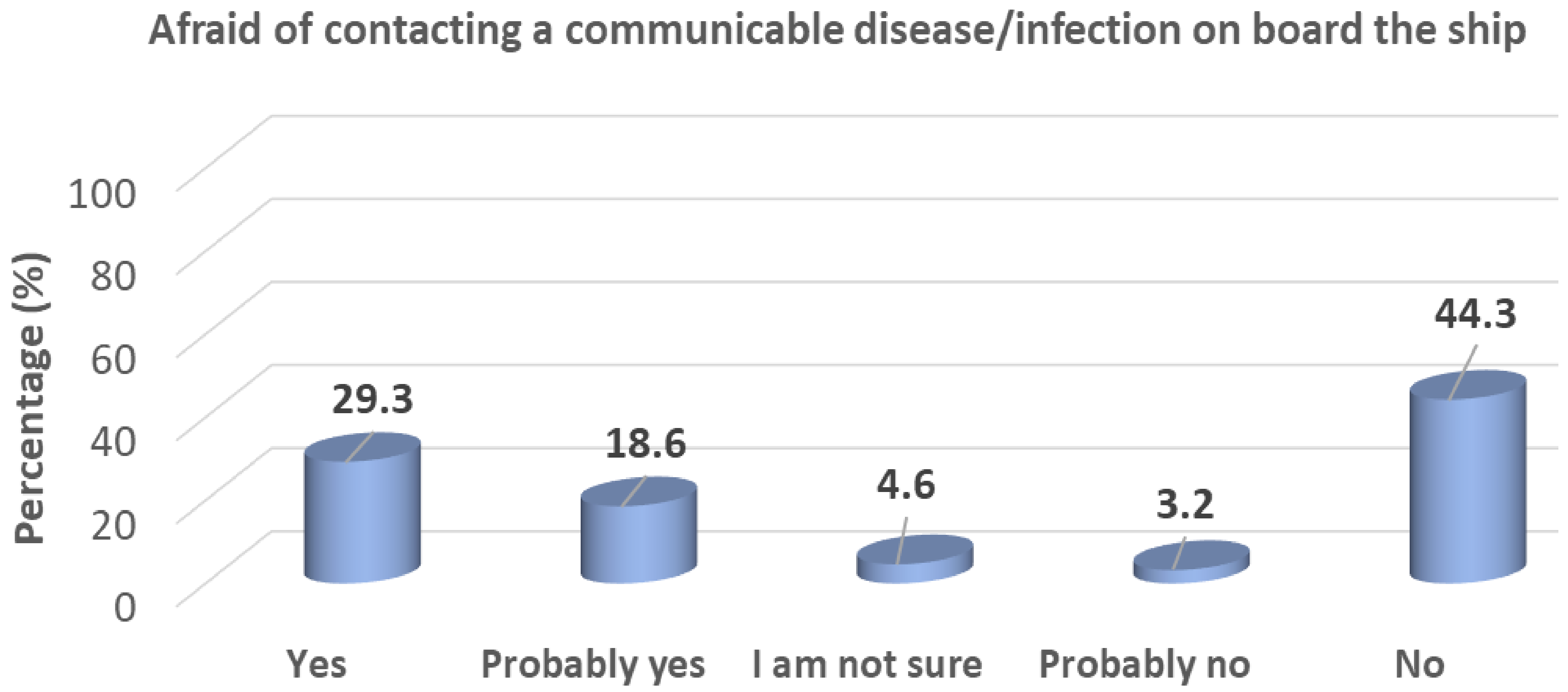
Results

Crew profile





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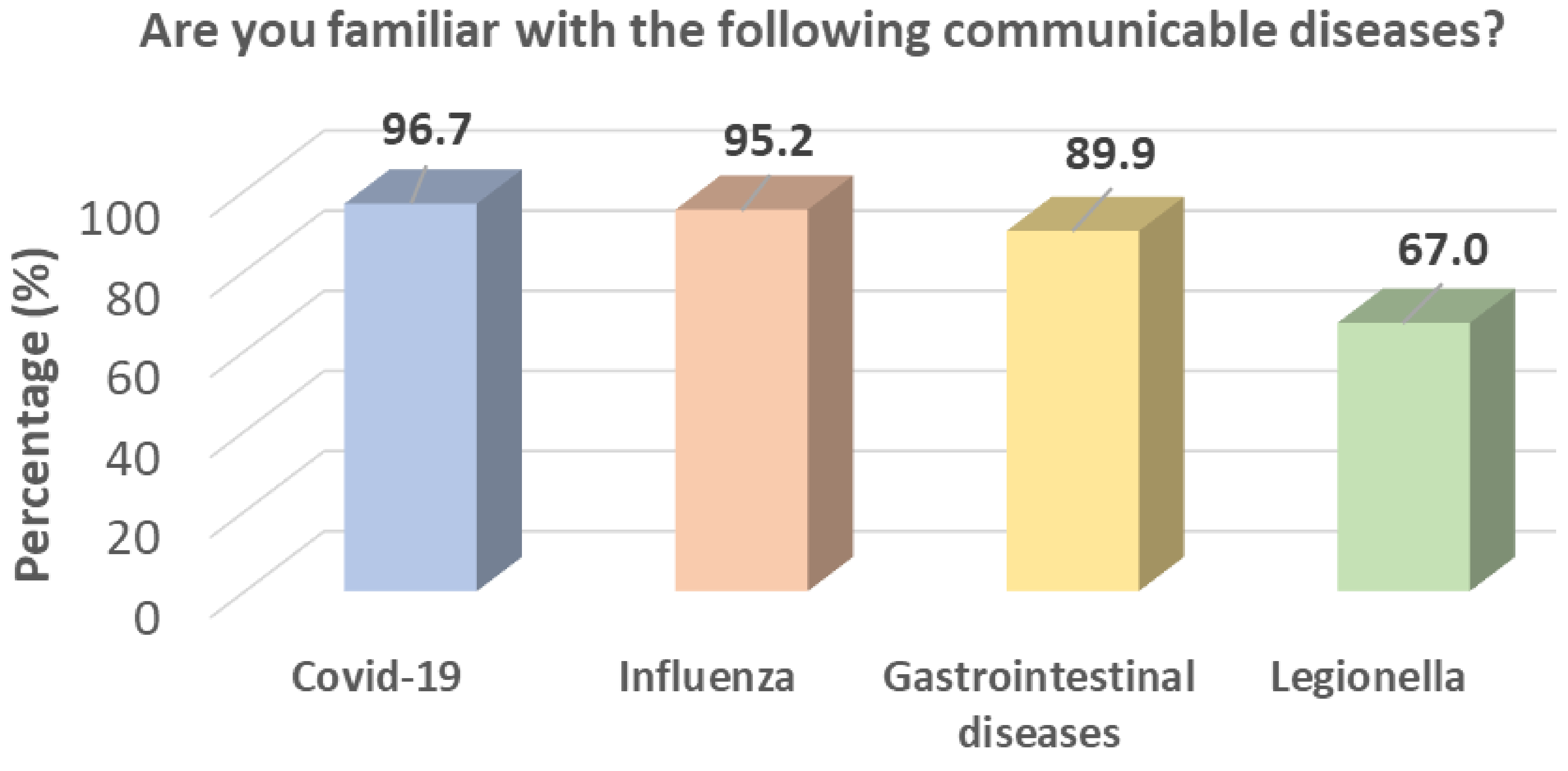
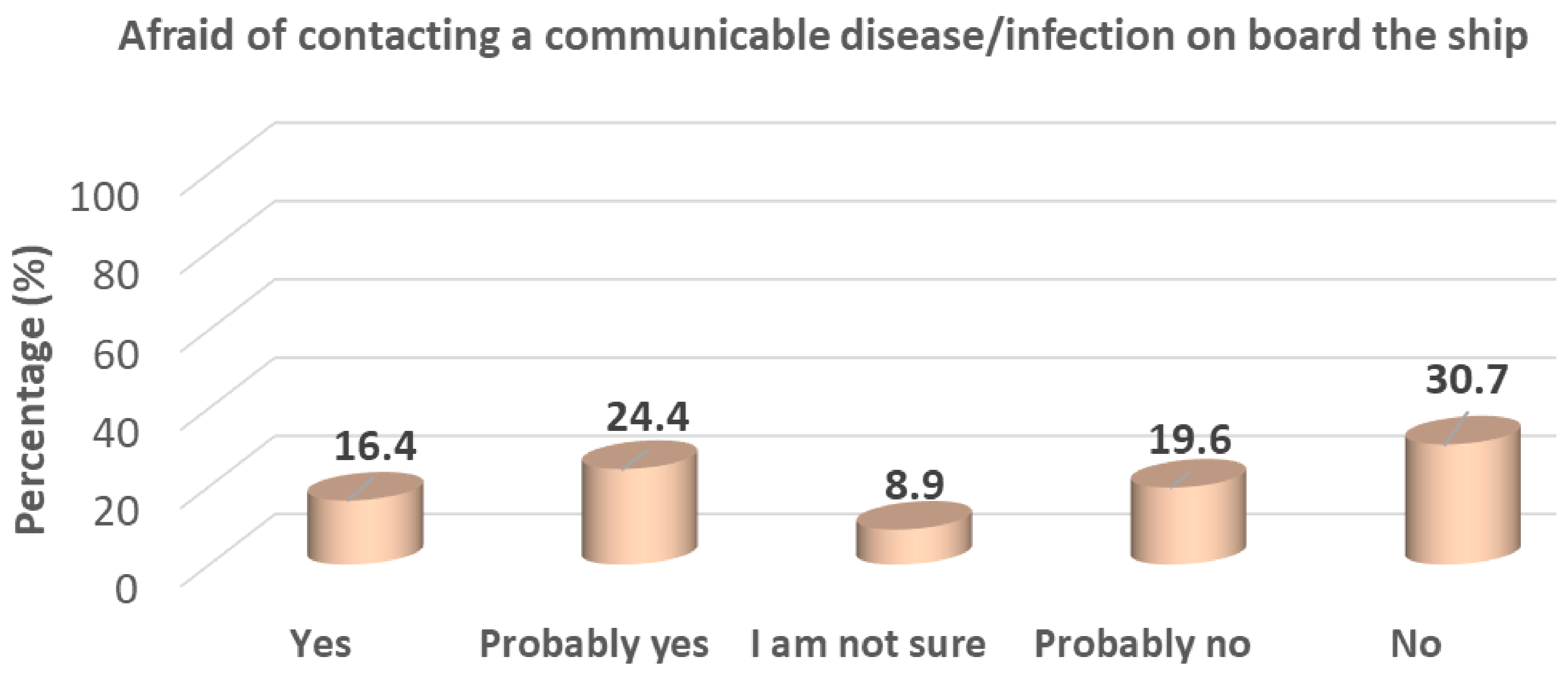
Results

Passengers' profile



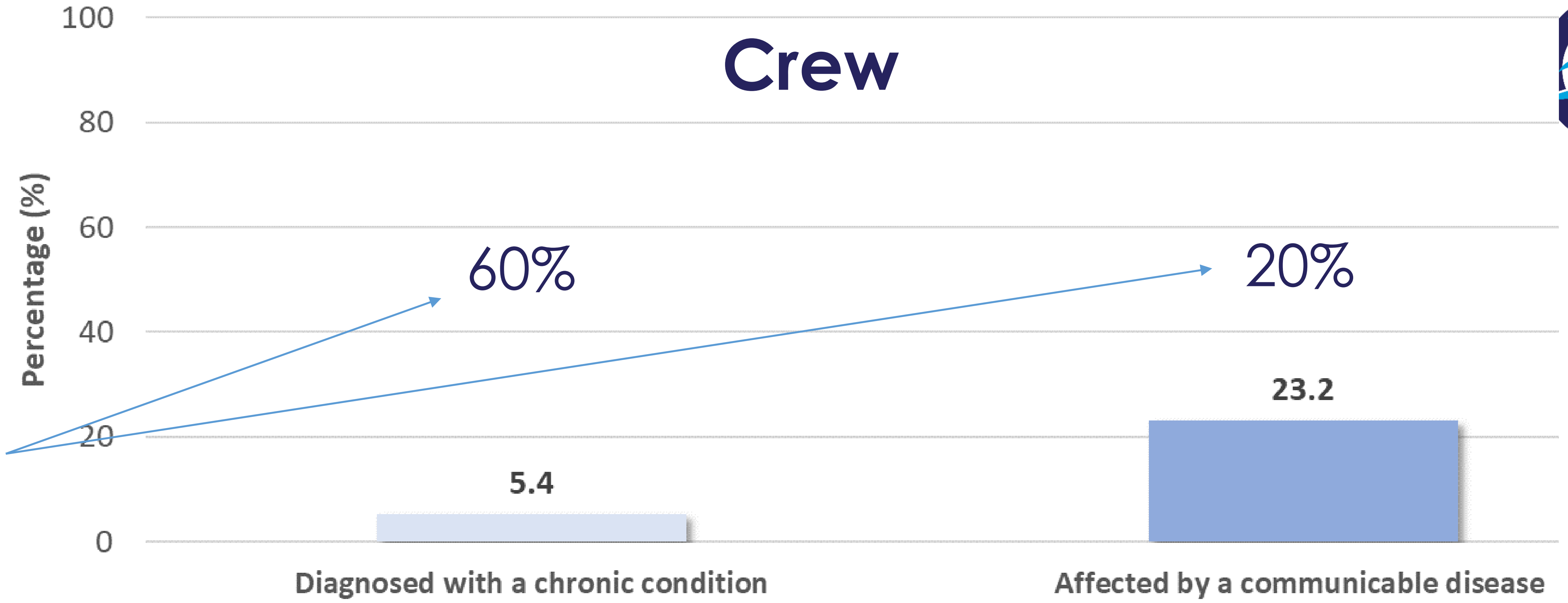


Funded by the European Union

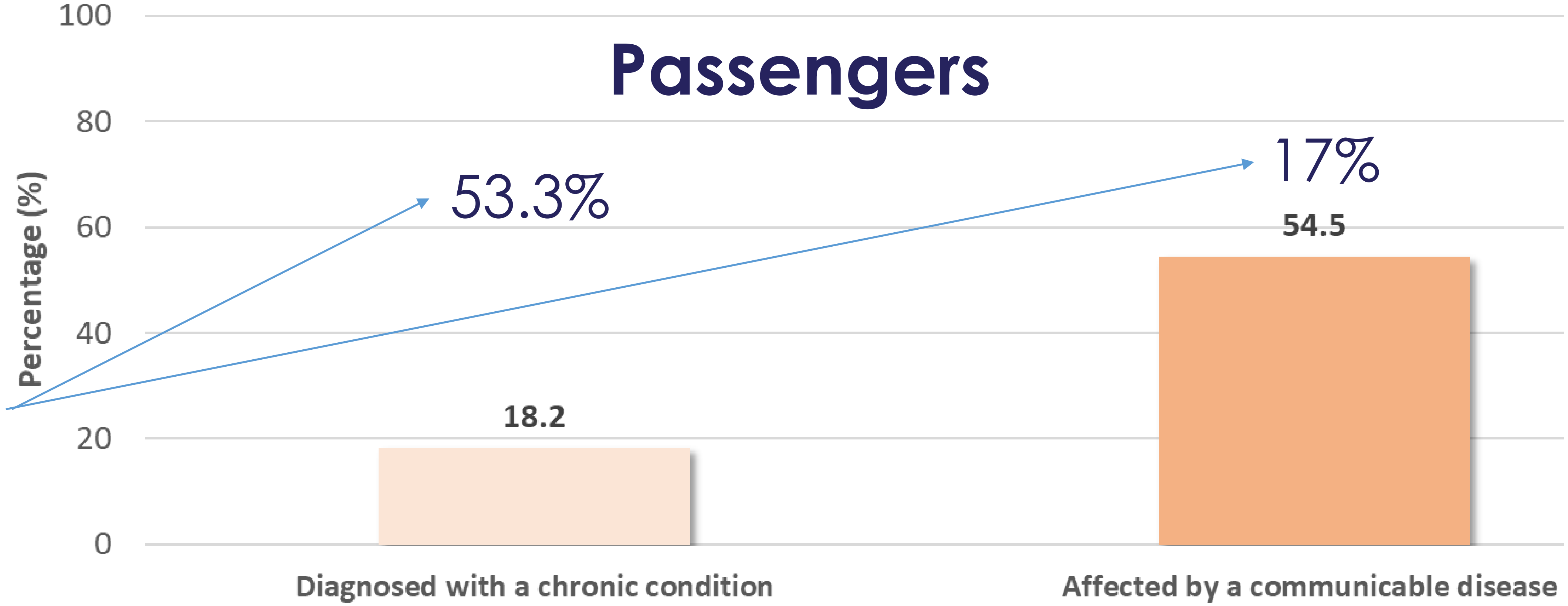
Results

Crew and passengers' profile

Hospitalized



Hospitalized



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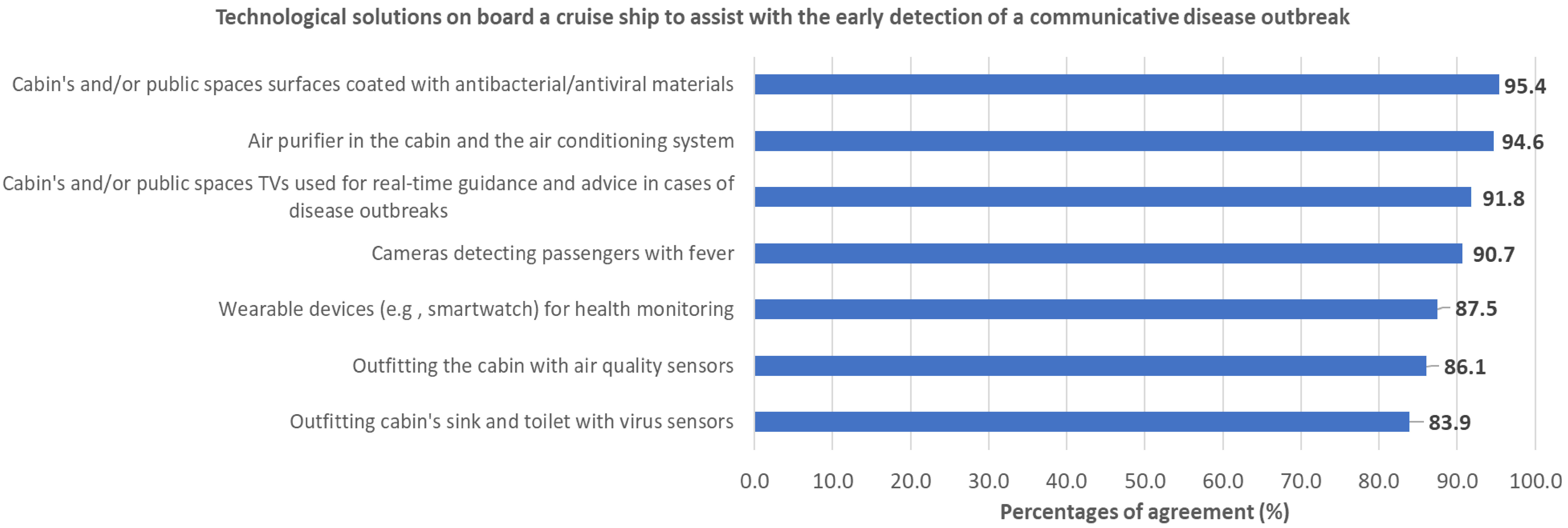
Results

Willingness to accept technological solutions **Crew**

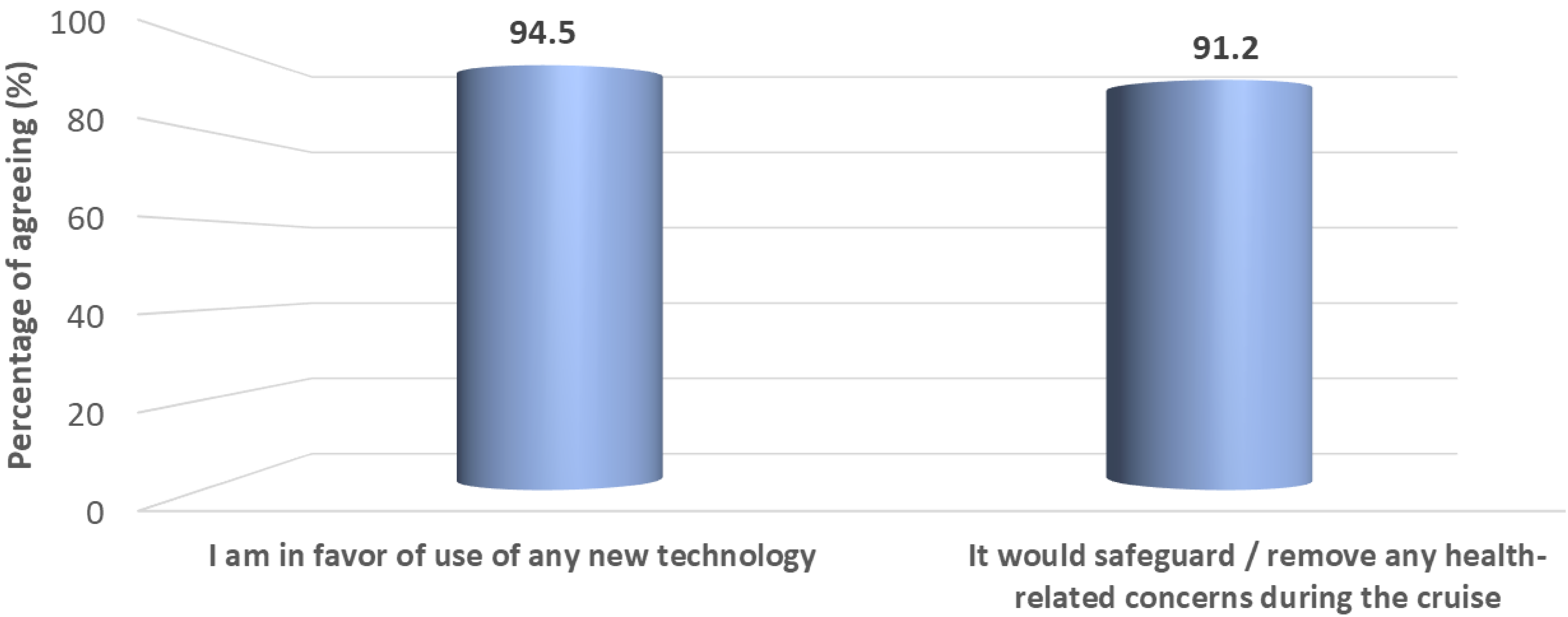


Funded by the European Union

Results

Reasons for agreeing with the technological solutions

Crew

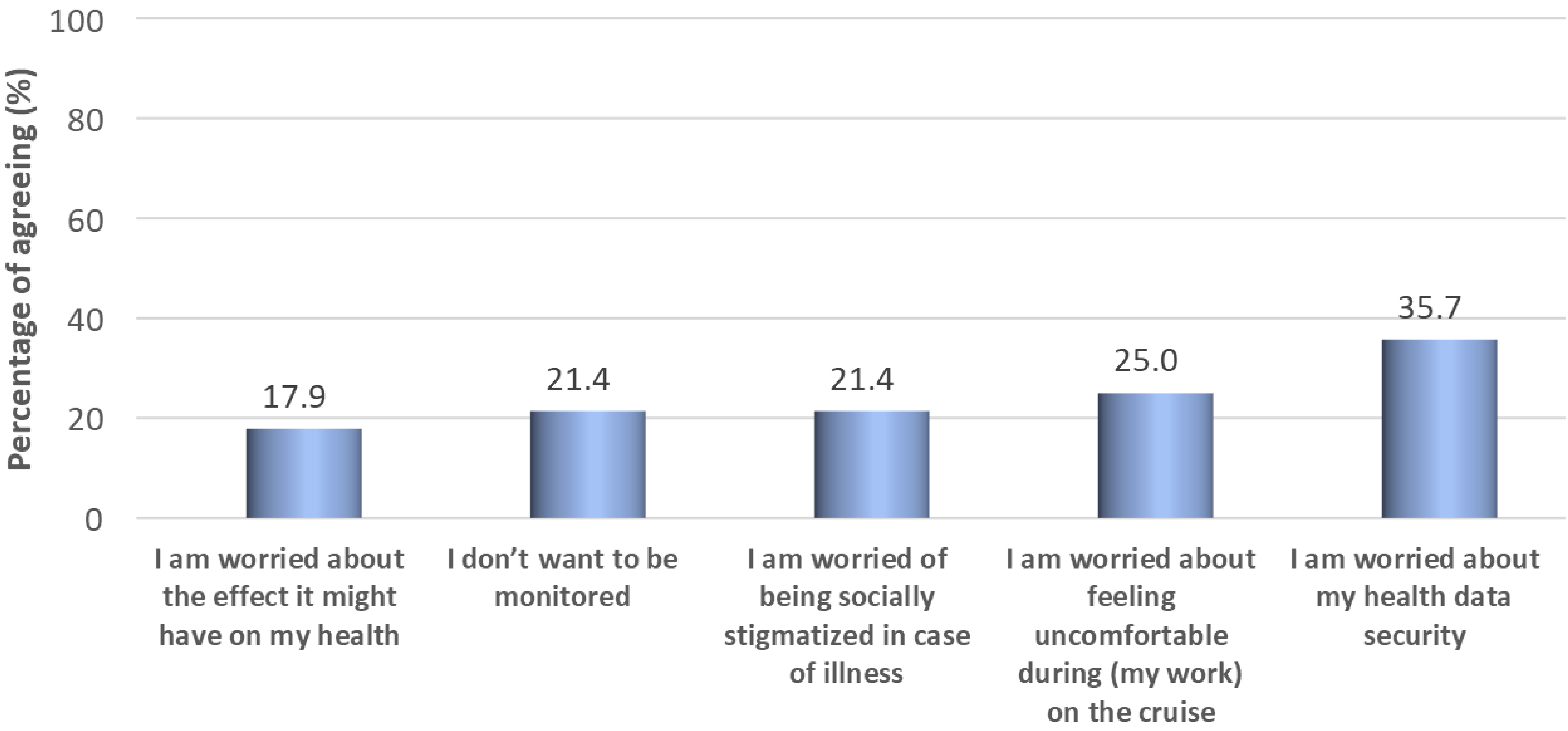


Funded by the European Union

Results

Reasons for **dis**agreeing with the technological solutions

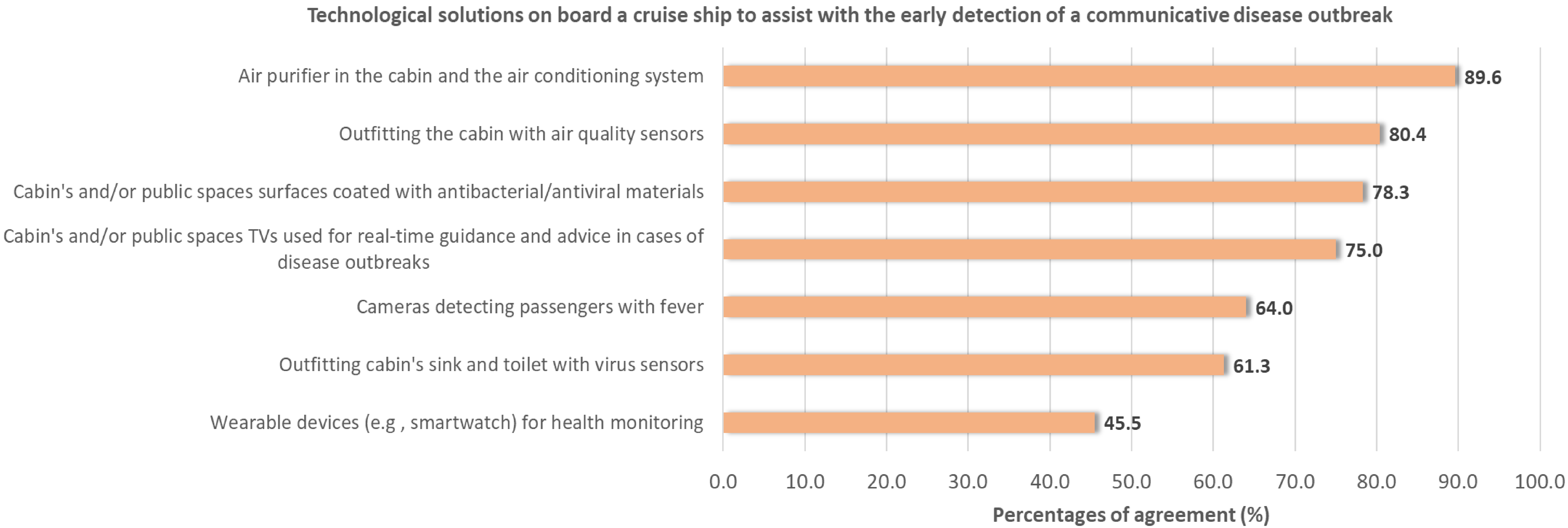
Crew



Funded by the European Union

Results

Willingness to accept technological solutions **Passengers**

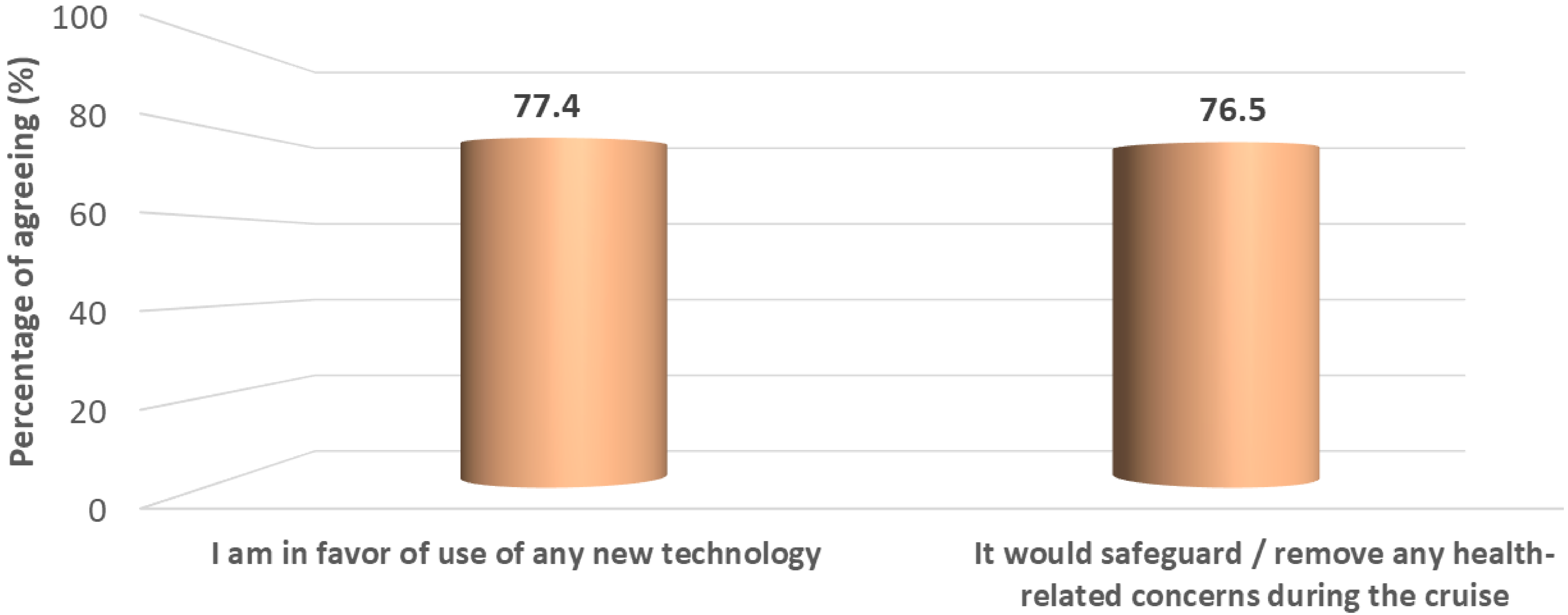


Funded by the European Union

Results

Reasons for agreeing with the technological solutions

Passengers

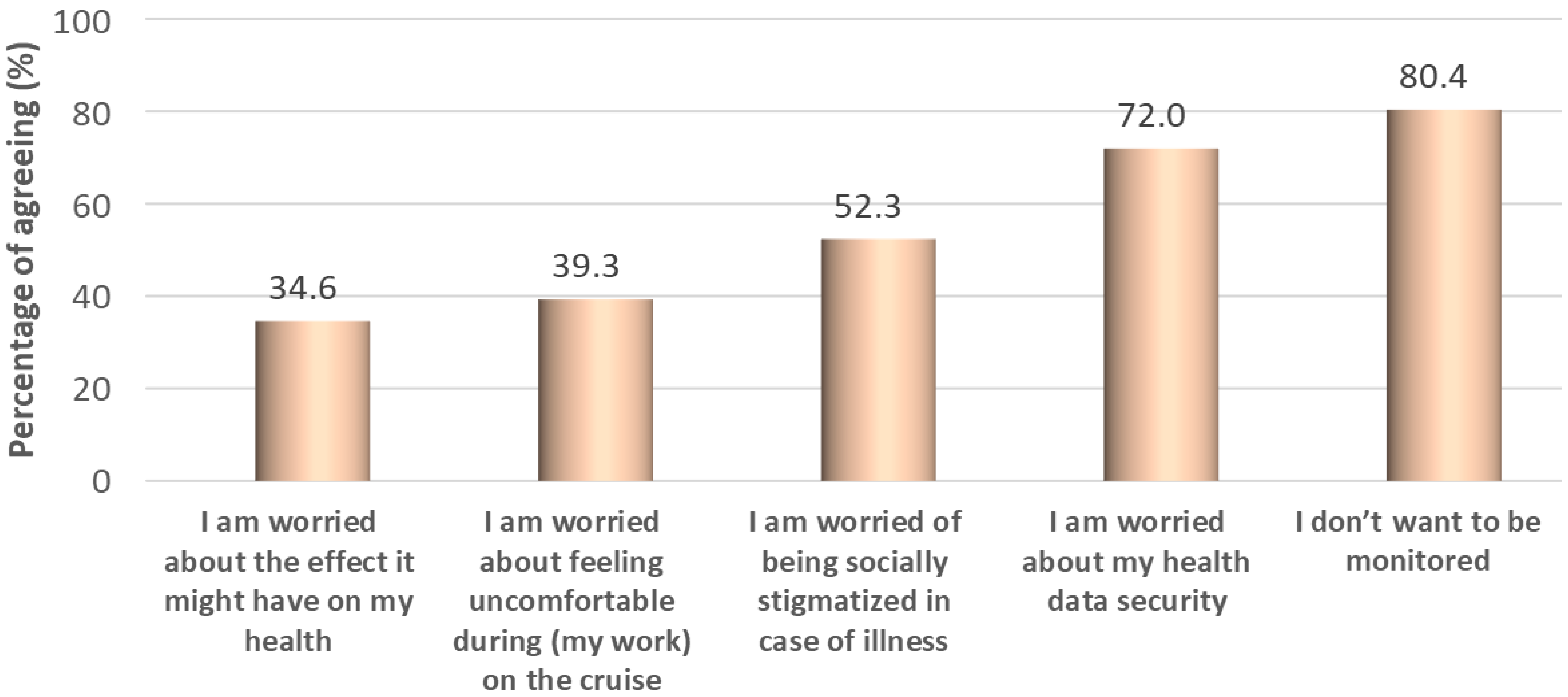


Funded by the European Union

Results

Reasons for **dis**agreeing with the technological solutions

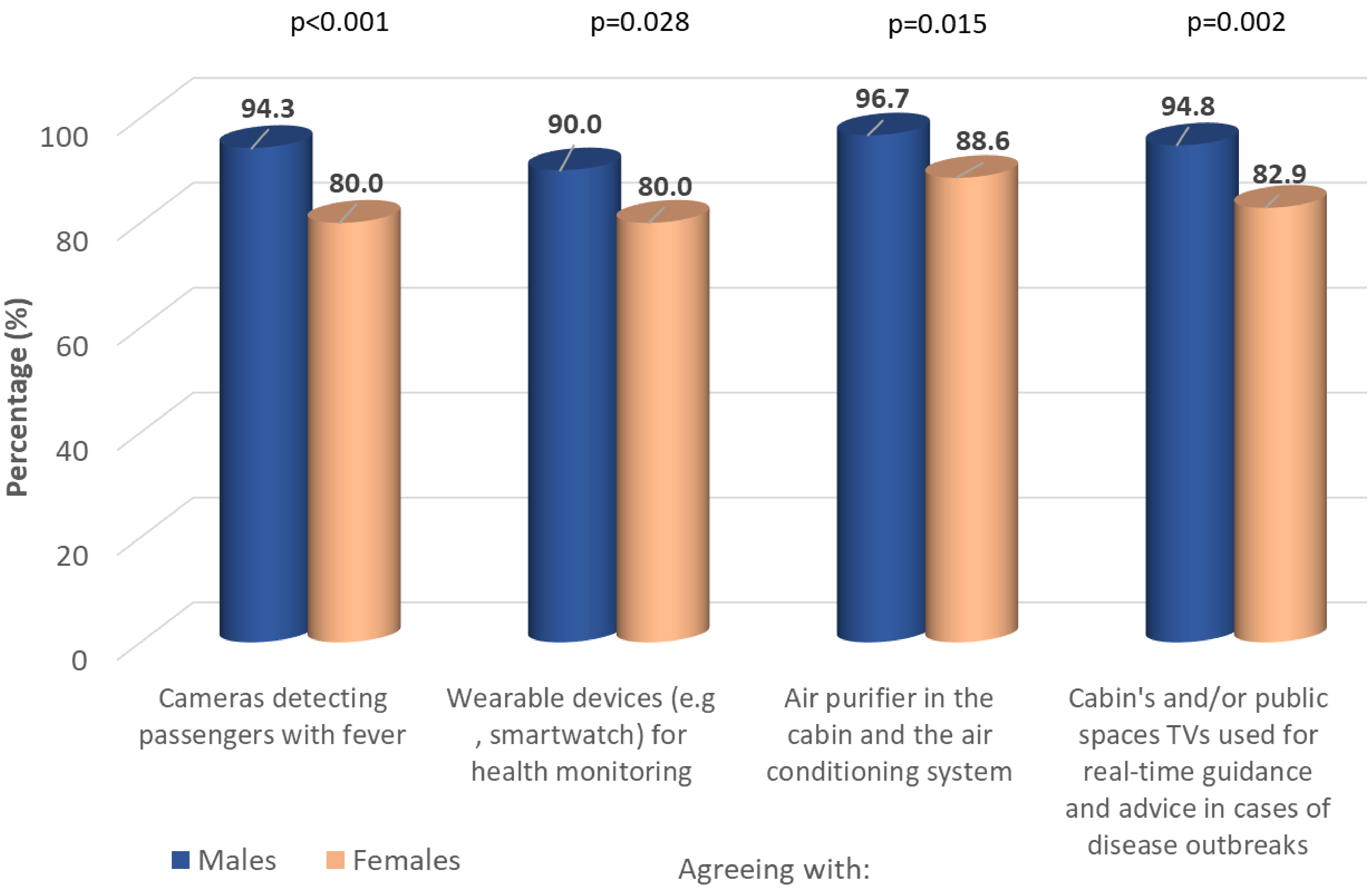
Passengers



Funded by the European Union

Analysis

Female crew members agreed in a significant lower percentage with these solutions:



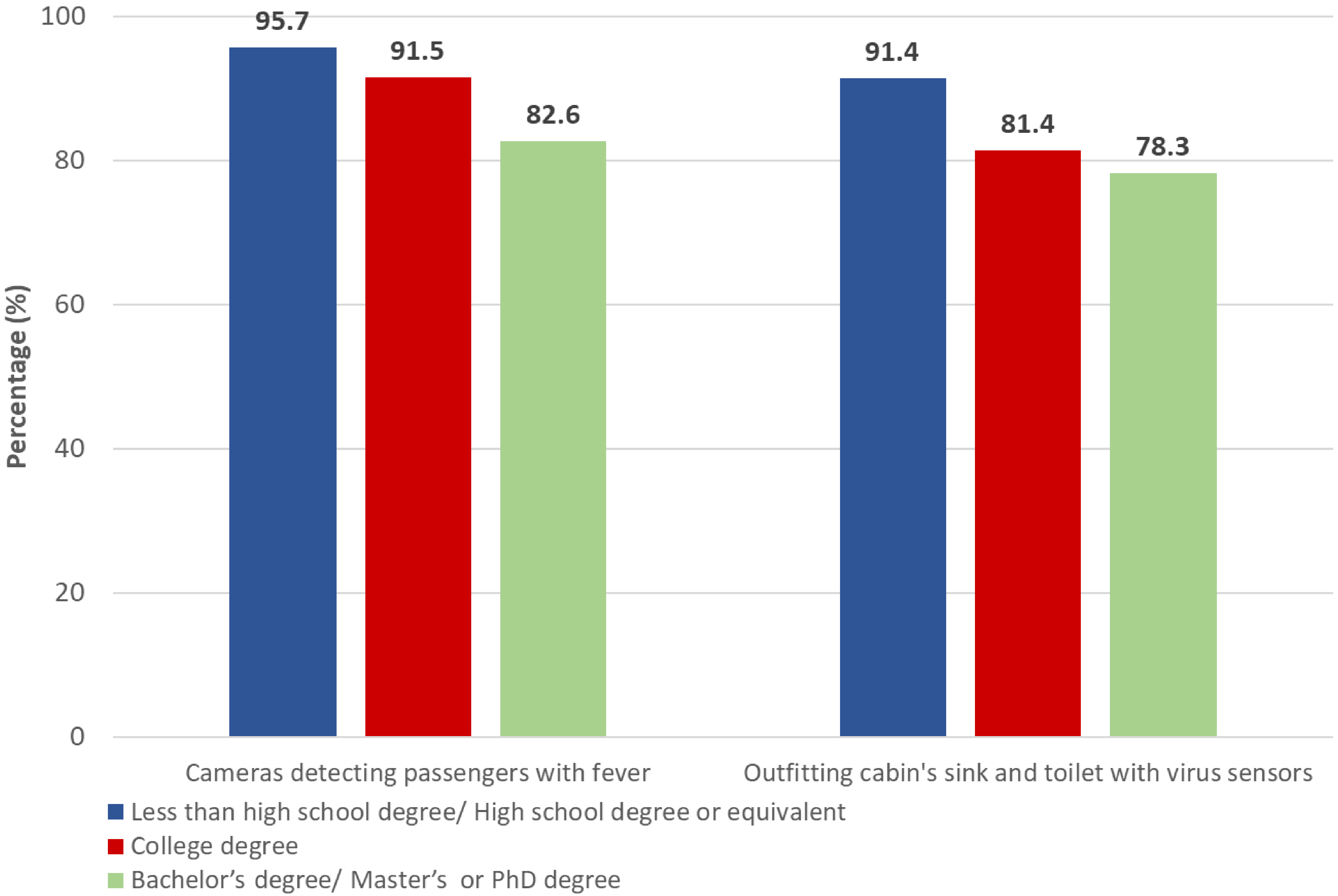
Funded by the European Union

Analysis

Greater educational level for crew members was significantly associated with **lower** agreement with

Cameras detecting passengers with fever (p=0.016)

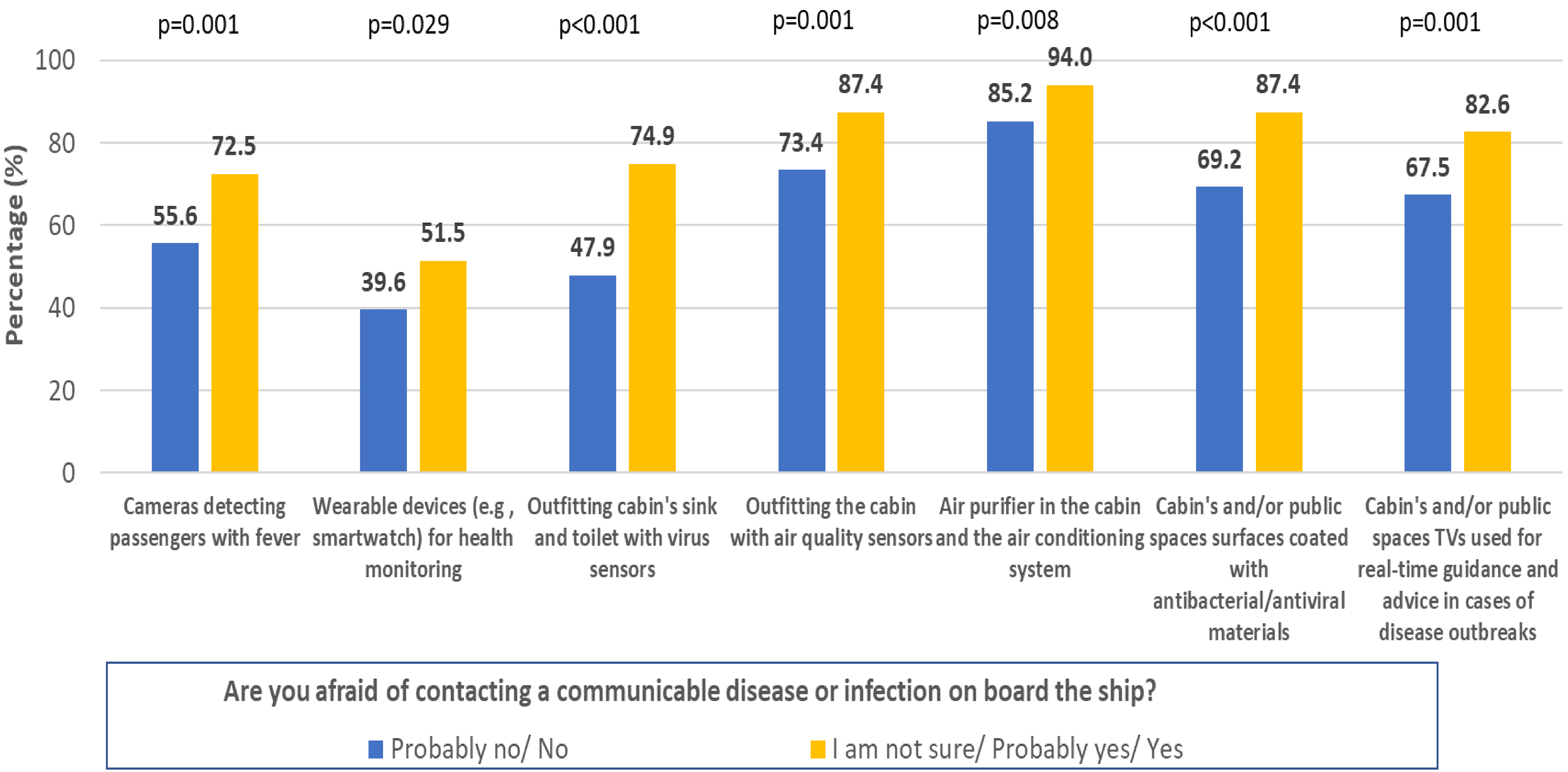
Outfitting cabin's sink and toilet with virus sensors (p=0,048)



Funded by the European Union

Analysis

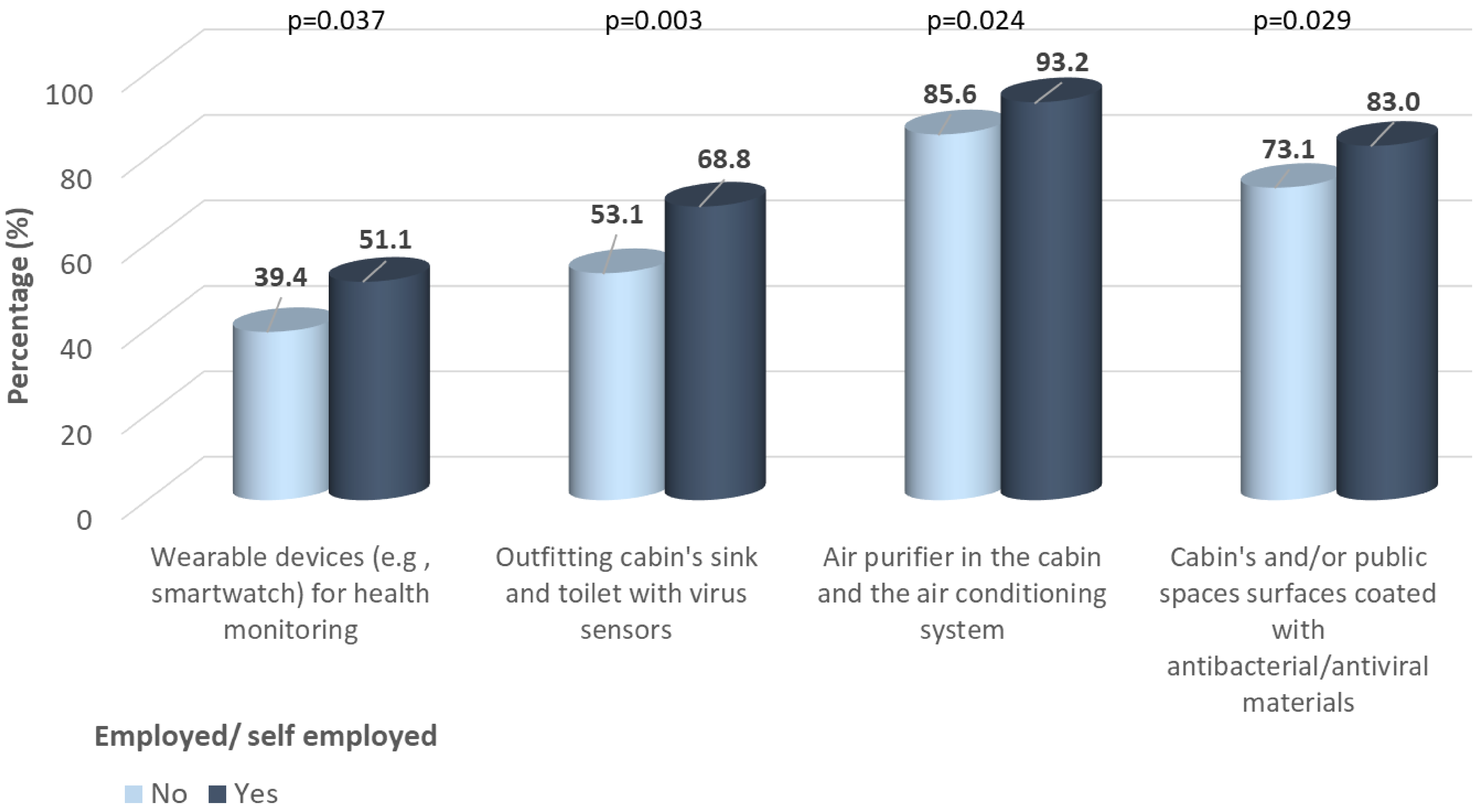
Passengers who were not afraid of contacting a communicable disease or infection on board the ship agreed with all solutions in **significantly lower** percentages



Funded by the European Union

Analysis

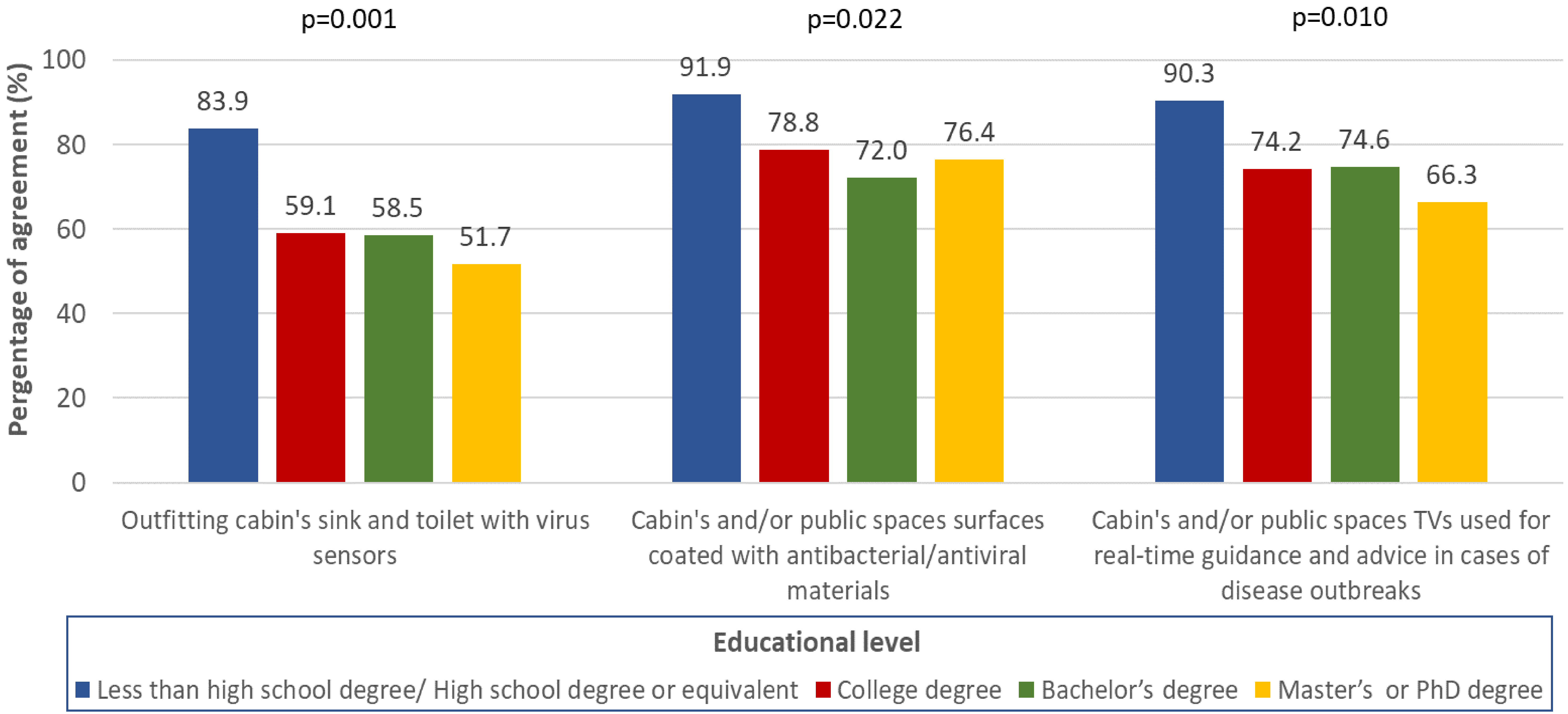
Passengers who were employed agreed with these solutions in **significantly greater** percentages



Funded by the European Union

Analysis

Greater educational level for passengers was significantly associated with **lower** agreement with these solutions:



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Analysis

Association with crew profile and demographics

Crew members who worked for the 1st time on a cruise ship agreed in a significantly lower percentage with:

- Outfitting the cabin with air quality sensors, 72.6% vs 87.2%; p=.008
- Outfitting cabin's sink and toilet with virus sensors, 75.8% vs 89%; p=.006

Crew members who agreed

- Cameras detecting passengers with fever (p=0.001)
- Outfitting cabin's sink and toilet with virus sensors (p=0.001)
- Outfitting the cabin with air quality sensors (p=0.001)

were significantly older.

Crew members who had been affected by a communicative disease agreed in a significantly greater percentage with outfitting the cabin with air quality sensors, 93.8% vs 83.7%; p=.039.

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Analysis

Association with passengers' profile and demographics

Passengers who been diagnosed with a chronic condition agreed with:

- Cameras detecting passengers with fever in a significantly lower %, 50.8% vs 66.9%; p=.026,
- Air purifier in the cabin and the air conditioning system in a significantly higher %, 96.7% vs 88%; p=.044

Passengers who agreed with

- Cameras detecting passengers with fever (p=0.008)
- Wearable devices (e.g , smartwatch) for health monitoring (p=0.012) and
- Outfitting cabin's sink and toilet with virus sensors (p=0.004)

were **significantly younger.**

Female passengers agreed in a significant lower percentage with Wearable devices (e.g , smartwatch) for health monitoring compared to men, 41% vs 52.7%; p=0.036

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Analysis

Association of reasons for agreeing with participants' profile

With the reason **"It would safeguard / remove any health-related concerns during the cruise"** agreed in a significantly lower percentage:

- The crew members who had been affected by a communicable disease, 84.4% vs 93.3%; p=.026,
- The crew members who had been diagnosed with a chronic disease, 66,7% vs 92,7%; p=.006.

With the reason **"I am in favour of use of any new technology"** agreed in a significantly lower percentage:

- The passengers who had been affected by a communicable disease, 72.8% vs 83.2%; p=.030,

The passengers who had been diagnosed with a chronic disease agreed in a significantly lower percentage with:

- **It would safeguard/remove any health-related concerns during the cruise**, 62.7% vs 79.7%; p=.006
- **I am in favor of use of any new technology**, 66.1% vs 80.1%; p=.021.

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Analysis

Association of reasons for **dis**agreeing with crew profile

Crew members **who were afraid of contacting a communicable disease or infection** on board the ship **disagreed** in a significantly **lower** percentage because

- I am worried about my health data security, 17.6% vs 63.6%; p=.020, or
- I am worried about feeling uncomfortable during (my work) on the cruise, 5.9% vs 54.5%; p=.007

Crew members **who had been affected by a communicative disease disagreed** in a significantly **greater** percentage because

- I am worried about my health data security, 75% vs 20%; p=.011, or
- I am worried about the effect it might have on my health, 50% vs 5%; p=.015

Crew members who were working for the 1st time in a cruise disagreed in a significantly **lower** percentage because

- I am worried about my health data security, 14.3% vs 57.1%; p=.018, or
- I am worried about the effect it might have on my health, 0% vs 35.7%; p=.041

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Analysis

Association of reasons for **dis**agreeing with passenger profile

Passengers **who were afraid of contacting a communicable disease or infection on board the ship disagreed** in a significantly **greater** percentage because

- I am worried of being socially stigmatized in case of illness, 71.1% vs 42%; p=.004, or
- I am worried about feeling uncomfortable during my work on the cruise, 52.6% vs 31.9%; p=.035

Passengers **who had been diagnosed with a chronic disease disagreed** in a significantly **greater** percentage because

- I am worried about the effect it might have on my health, 52% vs 29.3%; p=.036

Passengers **who had noticed any health or sanitation safety measures in place on board the ship**, particularly for communicable diseases **disagreed** in a significantly **greater** percentage because

- I am worried about my health data security, 76.8% vs 56%; p=.042.

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Analysis

Factors Association for Crew

Factor	More technological solutions	Less technological solutions
Knowledge of one of the diseases		X
Greater age		X
Using technology less for entertainment/work/keep up with the news		X
Afraid of contacting a communicable disease on board	X	
Diagnosed with a chronic condition	X	

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Analysis

Factors Association for Crew and Reasons for disagreeing

Factor	Greater score	Lower score
Female crew	X	
Crew members working for the 1st time	X	
Crew members with knowledge of the communicable diseases		X
Crew members affected by a communicable disease		X
Crew members who were afraid of contacting a communicable disease		X
Greater age	X	

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Analysis

Factors Association for Passengers

Factor	More technological solutions	Less technological solutions
Passengers with high school degree or less		X
Employed / Self-employed		X
Passengers with MSc / PhD	X	
Afraid of contacting a communicable disease	X	

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Analysis

Factors Association for Passengers and Reasons for either agreeing or disagreeing

Reasons for agreeing	Greater score	Lower score
Passengers who had been diagnosed with a chronic condition		X
Passengers who had noticed any health or sanitation safety measures in place on board the ship		X

Reasons for disagreeing	Greater score	Lower score
Passengers who spent more hours daily for monitoring health vitals/exercise routines via technology	X	
Passengers who spent more hours daily to perform work/duties or keep up with the news via technology	X	

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Tasks

- **Systematic Literature Review**

  Guidelines, Recommendations, Technological solutions, Prevalent communicable diseases

- **Workshop with internal stakeholders**

  Cruise partners, Technological partners, Validation of the SLR's findings

- **Survey**

  Stated preference surveys, Passengers and Crew, Willingness to adopt technological solutions

- **Report**

  Presentation of the methodology and analysis of the Survey's findings

- **Workshop with external stakeholders**

  Review, Comments, Validation of the methodology and findings of D2.1

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Workshop Objectives

Prior to the meeting a draft version of Deliverable 2.1 "*Mappings of existing framework conditions, challenges, system failures and gap analysis*" was sent to the participants

Main task

Review and discuss the methodology and key findings of D2.1. based on your expert knowledge

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Thank you for your attention!

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ANNEX 5 – Extraction Tables for publications and online documents included in the SLR

Table 27: Extraction table for scientific publications

ID	Title	First author	Journal	Year	Study type	DOI
1	Cruise Ships and Passenger Health	Peter A. Leggat	Springer, Singapore	2021	Chapter in book	https://doi.org/10.1007/978-981-16-5415-2_21
2	Infections on Cruise Ships	Vivek Kak	Microbiol Spectrum	2015	Review	https://doi.org/10.1128/microbiolspec.IOL5-0007-2015
3	Coronavirus (Covid-19) outbreak on the cruise ship Diamond Princess	Eilif Dahl	International Maritime Health	2020	Observational/editorial	10.5603/MH.2020.0003
4	Systematic Review on Outbreaks of SARS-CoV-2 on Cruise, Navy and Cargo Ships	Ann-Christin Kordsmeyer	Int J Environ Res Public Health	2021	Systematic review	10.3390/ijerph18105195
5	The cruise industry and the COVID-19 outbreak	Hirohito Ito	Transp Res Interdiscip Perspect	2020	Observational	10.1016/j.trip.2020.100136
6	Epidemiology of Coronavirus Disease Outbreak among Crewmembers on Cruise Ship, Nagasaki City, Japan, April 2020	Haruka Maeda	Emerging Infectious Diseases	2021	Observational	10.3201/eid2709.204596

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7	How to control cruise ship disease risk? Inspiration from the research literature	Hua Li	Mar Policy.	2021	Review	10.1016/j.marpol.2021.104652
8	Travellers and influenza: risks and prevention	M Goeijenbier	J Travel Med	2017	Review	10.1093/jtm/taw078.
9	Coronavirus Disease 2019 (COVID-19) in Americans Aboard the Diamond Princess Cruise Ship	Mateusz M Plucinski	Clin Infect Dis	2021	Observational	10.1093/cid/ciaa1180
10	Influenza epidemic on a world cruise ship: A descriptive study	Yoshihiro Aoki	Travel Med Infect Dis	2021	Letter to the editor	10.1016/j.tmaid.2021.102176
11	Challenges of COVID-19 outbreak on the cruise ship Diamond Princess docked at Yokohama, Japan: a real-world story	Hanako Jimi	Glob Health Med	2020	Review	10.35772/ghm.2020.01038
12	Prevention and Control of COVID-19 Pandemic on International Cruise Ships: The Legal Controversies	Xiaohan Zhang	Healthcare (Basel)	2021	Review	10.3390/healthcare9030281
13	Dynamic network strategies for SARS-CoV-2 control on a cruise ship	Samuel M Jenness	Epidemics	2021	Experimental/modelling	10.1016/j.epidem.2021.100488

14	Insights on Coronavirus Disease 2019 Epidemiology From a Historic Cruise Ship Quarantine	Takuya Yamagishi	Clin Infect Dis	2021	Commentary	10.1093/cid/ciaa1214
15	Gastroenteritis outbreaks on cruise ships: contributing factors and thresholds for early outbreak detection	Varvara A Mouchtouri	Euro Surveill	2017	Observational	10.2807/1560-7917.ES.2017.22.45.16-00576
16	Epidemiology of COVID-19 Outbreak on Cruise Ship Quarantined at Yokohama, Japan, February 2020	Expert Taskforce for the COVID-19 Cruise Ship Outbreak	Emerg Infect Dis	2020	Observational	10.3201/eid2611.201165
17	Symptoms and laboratory manifestations of mild COVID-19 in a repatriated cruise ship cohort	C R Bailie	Epidemiol Infect	2021	Observational	10.1017/S0950268821000315
18	COVID-19: in the footsteps of Ernest Shackleton	Alvin J Ing	Thorax	2020	Observational	10.1136/thoraxjnl-2020-215091
19	The Bayesian Susceptible-Exposed-Infected-Recovered model for the outbreak of COVID-19 on the Diamond Princess Cruise Ship	Chao-Chih Lai	Stoch Environ Res Risk Assess	2021	Observational	10.1007/s00477-020-01968-w
20	Minimizing disease spread on a quarantined cruise ship:	Berlinda Batista	Math Biosci	2020	Observational	10.1016/j.mbs.2020.108442

	A model of COVID-19 with asymptomatic infections					
21	Public Health Responses to COVID-19 Outbreaks on Cruise Ships — Worldwide, February–March 2020	Leah F Moriarty	MMWR Morb Mortal Wkly Rep	2020	Observational	10.15585/mmwr.mm6912e3
22	COVID-19: cross-border contact tracing in Germany, February to April 2020	Inessa Markus	Euro Surveill	2021	Observational	10.2807/1560-7917.ES.2021.26.10.2001236
23	Use of US Public Health Travel Restrictions during COVID-19 Outbreak on Diamond Princess Ship, Japan, February-April 2020	Alexandra M Medley	Emerg Infect Dis	2021	Review	10.3201/eid2703.203820
24	Viral transmission and evolution dynamics of SARS-CoV-2 in shipboard quarantine	Ting-Yu Yeh	Bull World Health Organ	2021	Meta-analysis of data	10.2471/BLT.20.255752
25	Preparation for Quarantine on the Cruise Ship Diamond Princess in Japan due to COVID-19	Yoshihiro Yamahata	JMIR Public Health Surveill	2020	Observational	10.2196/18821
26	COVID-19 Outbreak on a Passenger Ship and Assessment of Response Measures, Greece, 2020	Sophia Hatzianastasiou	Emerg Infect Dis	2021	Observational	10.3201/eid2707.210398

27	COVID-19 outbreak on the Costa Atlantica cruise ship: use of a remote health monitoring system	Eiichiro Sando	J Travel Med	2021	Letter to the editor	10.1093/jtm/taaa163
28	Influenza on cruise ships	Barnaby E Young	J Travel Med	2018	Observational/editorial	10.1093/jtm/tay146
29	Legionnaires' Disease in Hotels and Passenger Ships: A Systematic Review of Evidence, Sources, and Contributing Factors	Varvara A Mouchtouri	J Travel Med	2015	Systematic review	10.1111/jtm.12225
30	An outbreak of multiple norovirus strains on a cruise ship in China, 2014	X Wang	J Appl Microbiol	2016	Observational	10.1111/jam.12978
31	Contact infection of infectious disease onboard a cruise ship	Nan Zhang	Sci Rep	2016	Observational	10.1038/srep38790
32	A comparative analysis of control measures on-board ship against COVID-19 and similar novel viral respiratory disease outbreak: Quarantine ship or disembark suspects?	Arun Gupta	Med J Armed Forces India	2021	Observational	10.1016/j.mjafi.2020.06.003

33	Lessons learned for COVID-19 in the cruise ship industry	Rebecca K Brewster	Toxicol Ind Health	2020	Commentary	https://doi.org/10.1177/0748233720964631
34	Cruise ship pathologies in remote regions	Mathieu Carron	Int Marit Health	2018	Observational	10.5603/IMH.2018.0012
35	Respiratory infections and gastrointestinal illness on a cruise ship: A three-year prospective study	Androula Pavli	Travel Med Infect Dis	2016	Observational	10.1016/j.tmaid.2016.05.019
36	SARS-CoV-2 infections among Australian passengers on the Diamond Princess cruise ship: A retrospective cohort study	Liz J Walker	PLoS One	2021	Observational	10.1371/journal.pone.0255401
37	Successful Control of an Onboard COVID-19 Outbreak Using the Cruise Ship as a Quarantine Facility, Western Australia, Australia	Tudor A Codreanu	Emerg Infect Dis	2021	Observational	10.3201/eid2705.204142
38	Taking account of asymptomatic infections: A modeling study of the COVID-19 outbreak on the Diamond Princess cruise ship	Li-Shan Huang	PLoS One	2021	Observational	10.1371/journal.pone.0248273
39	An emergency responding mechanism for cruise	Xiaofei Liu	Mar Policy	2021	Review	10.1016/j.marpol.2020.104093

	epidemic prevention-taking COVID-19 as an example					
40	Epidemiology and quarantine measures during COVID-19 outbreak on the cruise ship Diamond Princess docked at Yokohama, Japan in 2020: a descriptive analysis	Motoyuki Tsuboi	Glob Health Med	2020	Observational	10.35772/ghm.2020.01037
41	COVID-19 outbreak on the Diamond Princess cruise ship: estimating the epidemic potential and effectiveness of public health countermeasures	J Rocklöv	J Travel Med	2020	Observational	10.1093/jtm/taaa030
42	Acute Gastroenteritis on Cruise Ships - Maritime Illness Database and Reporting System, United States, 2006-2019	Keisha A Jenkins	MMWR Surveill Summ	2021	Observational	10.15585/mmwr.ss7006a1
43	Diarrhea and related factors among passengers on world cruises departing from Japan	Michiyo Yamakawa	Travel Med Infect Dis	2018	Observational	10.1016/j.tmaid.2018.01.004
44	Legionella risk assessment in cruise ships and ferries	Pasqualina Laganà	Ann Agric Environ Med	2017	Observational	10.26444/aaem/74717
45	Chronology of COVID-19 Cases on the Diamond Princess Cruise Ship and	Eisuke Nakazawa	Disaster Med Public Health Prep	2020	Review	10.1017/dmp.2020.50

	Ethical Considerations: A Report From Japan					
46	Harnessing testing strategies and public health measures to avert COVID-19 outbreaks during ocean cruises	Gerardo Chowell	Sci Rep	2021	Modelling	10.1038/s41598-021-95032-4
47	Gastroenteritis outbreaks on cruise ships: are sanitation inspection scores a true index of risk?	Christopher James Taylor	Int Marit Health	2018	Observational	https://pubmed.ncbi.nlm.nih.gov/30589061/
48	Patterns of illness and injury on Antarctic research cruises, 2004-2019: a descriptive analysis	Jenny T Visser	J Travel Med	2020	Observational	10.1093/jtm/taaa111
49	The roles of transportation and transportation hubs in the propagation of influenza and coronaviruses: a systematic review	Annie Browne	J Travel Med	2016	Systematic review	10.1093/jtm/tav002
50	Descriptive study of COVID-19 outbreak among passengers and crew on Diamond Princess cruise ship, Yokohama Port, Japan, 20 January to 9 February 2020	Takuya Yamagishi	Euro Surveill	2020	Observational/report	10.2807/1560-7917.ES.2020.25.23.2000272

51	Norovirus GII.Pe Genotype: Tracking a Foodborne Outbreak on a Cruise Ship Through Molecular Epidemiology, Brazil, 2014	Simone Guadagnucci Morillo	Food Environ Virol	2017	Observational	10.1007/s12560-016-9272-2.
52	Acute Gastroenteritis on Cruise Ships - United States, 2008-2014	Amy L Freeland	MMWR Morb Mortal Wkly Rep	2016	Observational/report	10.15585/mmwr.mm6501a1
53	Legal issues and challenges in addressing the coronavirus outbreak on large cruise ships: A critical examination of port state measures	Siqi Sun	Ocean Coast Manag	2022	Review	10.1016/j.ocecoaman.2021.105995
54	Estimation of the reproductive number of novel coronavirus (COVID-19) and the probable outbreak size on the Diamond Princess cruise ship: A data-driven analysis	Sheng Zhang	Int J Infect Dis	2020	Observational	10.1016/j.ijid.2020.02.033
55	Influenza-Like Illness Among Personnel Responding to U.S. Quarantine of Cruise Ship Passengers Exposed to SARS-CoV-2	R Reid Harvey	J Occup Environ Med	2022	Observational	10.1097/JOM.0000000000002335

56	Health measures to travellers and cruise ships in response to COVID-19	Varvara A Mouchtouri	J Travel Med	2020	Correspondence	10.1093/jtm/taaa043
57	Risk factors, immune response and whole-genome sequencing of SARS-CoV-2 in a cruise ship outbreak in Norway	Kirsten Gravningen	Int J Infect Dis	2022	Observational	10.1016/j.ijid.2022.02.025
58	Investigation and Source Apportionment of Air Pollutants in a Large Oceangoing Ship during Voyage	Qiang Wang	Int J Environ Res Public Health	2019	Observational	10.3390/ijerph16030389
59	Outbreak of Acute Gastroenteritis Caused by Norovirus Genogroup II Attributed to Contaminated Cold Dishes on a Cruise Ship in Chongqing, China, 2017	Li Qi	Int J Environ Res Public Health	2018	Observational	10.3390/ijerph15122823
60	Estimating the infection and case fatality ratio for coronavirus disease (COVID-19) using age-adjusted data from the outbreak on the Diamond Princess cruise ship, February 2020	Timothy W Russell	Euro Surveill	2020	Communication	10.2807/1560-7917.ES.2020.25.12.2000256

61	Detection of SARS-CoV-2 RNA in commercial passenger aircraft and cruise ship wastewater: a surveillance tool for assessing the presence of COVID-19 infected travellers	Warish Ahmed	J Travel Med	2020	Observational	10.1093/jtm/taaa116
62	Influenza Outbreaks Among Passengers and Crew on Two Cruise Ships: A Recent Account of Preparedness and Response to an Ever-Present Challenge	Alexander J Millman	J Travel Med	2015	Observational	10.1111/jtm.12215
63	Epidemiology of foodborne disease outbreaks from 2011 to 2016 in Shandong Province, China	Guangjian Wu	Medicine (Baltimore)	2018	Observational	10.1097/MD.0000000000013142
64	The contribution of asymptomatic SARS-CoV-2 infections to transmission on the Diamond Princess cruise ship	Jon C Emery	Elife	2020	Observational	10.7554/eLife.58699
65	Cruise Ship Travel in the Era of Coronavirus Disease 2019 (COVID-19): A Summary of Outbreaks and a Model of Public Health Interventions	Sarah Anne J Guagliardo	Clin Infect Dis	2022	Intervention	10.1093/cid/ciab433

66	Rapid Risk Assessment Report for Schistosomiasis Epidemic in Jianli County Caused by the Sunk "Oriental Star" Cruise Ship	Ziling Ni	Disaster Med Public Health Prep	2018	Observational	10.1017/dmp.2017.28
67	Environmental Sampling for Severe Acute Respiratory Syndrome Coronavirus 2 During a COVID-19 Outbreak on the Diamond Princess Cruise Ship	Takuya Yamagishi	J Infect Dis	2020	Observational	10.1093/infdis/jiaa437
68	Unique Evolution of SARS-CoV-2 in the Second Large Cruise Ship Cluster in Japan	Haruka Abe	Microorganisms	2022	Observational	10.3390/microorganisms1001009 9
69	Using the contact network model and Metropolis-Hastings sampling to reconstruct the COVID-19 spread on the "Diamond Princess"	Feng Liu	Sci Bull (Beijing)	2020	Observational	10.1016/j.scib.2020.04.043
70	Global Health Governance on Cruise Tourism: A Lesson Learned From COVID-19	Zhengliang Hu	Frontiers in Marine science	2022	Observational	10.1016/j.glohj.2020.11.006
71	Cruising through a pandemic: The impact of COVID-19 on intentions to cruise	Jennifer Holland	Transportation Research Interdisciplinary Perspectives	2021	Observational	https://doi.org/10.1016/j.trip.2021.100328

72	A Study on the Trends of the Global Cruise Tourism Industry, Sustainable Development, and the Impacts of the COVID-19 Pandemic	Li-Ying Lin	Sustainability	2022	Observational	https://doi.org/10.3390/su14116890
73	Cruise Ship Travel and the Spread of COVID-19 – Australia as a Case Study	Ashley L. Quigley	Int J Travel Med Glob Health.	2021	Observational	10.34172/IJTMGH.2021.03
74	Laboratory-based respiratory virus surveillance pilot project on select cruise ships in Alaska, 2013–15	Kimberly B Rogers	Journal of Travel Medicine	2017	Observational	https://doi.org/10.1093/jtm/tax069
75	Transmission potential of the novel coronavirus (COVID-19) onboard the diamond Princess Cruises Ship, 2020	Kenji Mizumoto	Infect Dis Model	2020	Observational	10.1016/j.idm.2020.02.003
76	Deep Transfer Learning for Communicable Disease Detection and Recommendation in Edge Networks.	Mainak Adhikari	IEEE/ACM Transactions on Computational Biology and Bioinformatics	2022	Modelling and simulation study	10.1109/TCBB.2022.3180393
77	Legionnaires' disease outbreak associated with a cruise liner, August 2003: epidemiological and microbiological findings	Beyrer K	Epidemiology and infection	2007	Case control study	10.1017/S0950268806007473

78	Legionella pneumophila strain associated with the first evidence of person-to-person transmission of Legionnaires' disease: a unique mosaic genetic backbone	Vítor Borges	Scientific Reports	2016	Research	10.1038/srep26261
79	Airborne route and bad use of ventilation systems as non-negligible factors in SARS-CoV-2 transmission.	Correia, G.	Medical Hypotheses	2020	Research	10.1016/j.mehy.2020.109781
80	On coughing and airborne droplet transmission to humans.	Talib Dbouk	Physics of Fluids (1994)	2020	Computational investigation	https://doi.org/10.1063/5.0011960
81	Weather impact on airborne coronavirus survival	Talib Dbouk	Physics of Fluids (1994)	2020	Computational investigation	https://doi.org/10.1063/5.0024272
82	Fluid dynamics and epidemiology: Seasonality and transmission dynamics	Talib Dbouk	Physics of Fluids (1994)	2021	Computational modeling	https://doi.org/10.1063/5.0037640
83	On airborne virus transmission in elevators and confined spaces	Talib Dbouk	Physics of Fluids (1994)	2021	Computational investigation	https://doi.org/10.1063/5.0038180
84	On pollen and airborne virus transmission	Talib Dbouk	Physics of Fluids (1994)	2021	Computational modeling and simulation	https://doi.org/10.1063/5.0055845

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85	Natural Ventilation and Aerosol Particles Dispersion Indoors	Talib Dbouk	Energies	2022	Computational investigation	https://doi.org/10.3390/en15145101
86	Reducing indoor virus transmission using air purifiers	Talib Dbouk	Physics of Fluids (1994)	2021	Computational investigation	https://doi.org/10.1063/5.0064115
87	Cruise Ship Travel	Carter D. Hill	Travel Medicine	2019	Chapter in book	10.1016/B978-0-323-54696-6.00040-9
88	Respiratory disease on cruise ships	Krista Kornylo	Clinical Infectious Diseases	2012	Editorial	https://doi.org/10.1093/cid/cis038
89	An epidemiological study of rates of illness in passengers and crew at a busy Caribbean cruise port	Cathy Ann Marshall	BMC Public Health	2016	Research article	https://doi.org/10.1186/s12889-016-2991-3
90	Prevention Is Better Than the Cure: Risk Management of COVID-19	Michael McAleer	Journal of Risk and Financial Management	2020	Editorial	https://www.mdpi.com/1911-8074/13/3/46
91	A Review of Piezoelectric and Magnetostrictive Biosensor Materials for Detection of COVID-19 and Other Viruses	Narita, F.	Advanced Materials	2021	Review	https://doi.org/10.1002/adma.202005448

92	A review of outbreaks of waterborne disease associated with ships: evidence for risk management	Roisin M. Rooney	Public health reports (Washington, D.C. : 1974)	2004	Research article	https://doi.org/10.1016/j.phr.2004.05.008
93	Reducing aerosol transmission of SARS-CoV-2 in hospital elevators	van Rijn, C.	Indoor Air	2020	Editorial	https://doi.org/10.1111/ina.12744
94	Global health governance for travel health: lessons learned from the coronavirus disease 2019 (COVID-19) outbreaks in large cruise ships	Zhou, S.	Global Health Journal	2020	Research	https://doi.org/10.1016/j.glohj.2020.11.006
95	Estimating the asymptomatic proportion of coronavirus disease 2019 (COVID-19) cases on board the Diamond Princess cruise ship, Yokohama, Japan, 2020.	Kenji Mizumoto	Euro Surveill.	2020	Statistical modelling	https://doi.org/10.2807/1560-7917.ES.2020.25.10.2000180
96	Bygiene: The New Paradigm of Bidirectional Hygiene	Al-Ghalith, G. A.	The Yale Journal of Biology and Medicine	2015	Review	https://pubmed.ncbi.nlm.nih.gov/26604859
97	Probiotic bacteria and biosurfactants for nosocomial infection control: a hypothesis	Falagas, M. E.	Journal of Hospital Infection	2009	Opinion	https://doi.org/10.1016/j.jhin.2008.12.008

98	Degradative Effect of Nattokinase on Spike Protein of SARS-CoV-2	Tanikawa, T.	Molecules	2022	Article	https://doi.org/10.3390/molecules27175405

Table 28: Extraction table for online documents

ID	Organization	Title	Type of document	Year
1	WHO	Handbook for management of public health events on board ships. International Health Regulations (2005)	Handbook	2020
2	WHO	Operational considerations for managing COVID-19 cases/outbreak on board ships	Guidebook	2020
3	WHO	Handbook for inspection of ships and issuance of ship sanitation certificates	Handbook	2011
4	WHO	Sea travel advice	Questions and answers	2020
5	ICS	International Chamber of Shipping (ICS). Coronavirus (COVID-19) - Guidance for Ship Operators for the Protection of the Health of Seafarers, Fifth Edition	Guidebook	2022
6	Healthy Gateways	Interim Advice for preparedness and response to cases of COVID-19 at points of entry in the European Union (EU)/ European Economic Area Members States (MS)	Recommendations	2020
7	Healthy Gateways	Guidelines for cruise ship operations in response to the COVID-19 pandemic	Guidebook	2022
8	ECDC	COVID-19: EU guidance for cruise ship operations	Recommendations	2021
9	CDC	Cruise Ship Color Status	Recommendations	2021
10	CDC	Cruise Ship Travel During COVID-19	Recommendations	2022

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11	CDC	Guidance for Cruise Ships on Influenza-like Illness (ILI) Management	Recommendations	2016
12	CDC	Interim Guidance for Ships on Managing Suspected or Confirmed Cases of Coronavirus Disease 2019 (COVID-19)	Recommendations	2022
13	CDC	Ship Crew Well-Being During COVID-19	Recommendations	2021
14	CDC	CDC Yellow Book 2020. Chapter 8: Cruise ship travel	Chapter	2019
15	CDC	Public Health Responses to COVID-19 Outbreaks on Cruise Ships — Worldwide, February–March 2020	Weekly report	2020
16	CDC	Guidance for Cruise Ships on the Mitigation and Management of COVID-19	Recommendations	2022
17	CDC	Vessel Sanitation Program 2018 Operations Manual	Guidebook	2018
18	CDC	Technical Instructions for Mitigation of COVID-19 Among Cruise Ship Crew	Recommendations	2021
19	EU SHIPSAN ACT JOINT ACTION (20122103)	European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. Second edition.	Manual	2016
20	EU SHIP SANITATIN TRAINING NETWORK - SHIPSAN TRAINET PROJECT ((2007206)	European Manual for Hygiene Standards and Communicable Disease Surveillance on Passenger Ships. European Commission Directorate General for health and consumers	Manual	2011

21	Norovirus Working Group. Health Protection Agency. MCA.	Guidance for the Management of Norovirus Infection in Cruise Ships	Recommendations	2007
22	ECDC- European Working Group for Legionella Infections	European Technical Guidelines for the prevention, control and investigation of infections caused by Legionella species (2017)	Recommendations	2017
23	Cruise Lines International Association (CLIA)	Cruise industry regulation	Regulation	2021