
Final Report

“Investigating the Increased Use of Digitalisation On board and Possible Benefits/Improvements to Shipboard Safety and Welfare”

March 2022



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1. Executive summary

In the context of the EU co-funded WESS project¹, ECSA and ETF are committed to assessing shipboard living and working conditions with a view to taking action to contribute to an “*attractive, smart and sustainable environment onboard*”. As part of this project, they wanted to investigate the increased use of digitalisation on board and possible benefits/improvements to shipboard safety² and welfare. This was the purpose of this particular research.

The starting point of the research was a desk-based exercise to map out and analyse existing research findings. Further to this, to get detailed insights as regards life on board, and the impact of increased digitalisation, the cornerstone of the research entailed reaching out to those with firsthand experience through online surveys. These surveys were circulated to a wide audience to gain a broad range of insights, targeting individual seafarers (791), as well as companies and interest representatives (46). The aim was to hear about digitalisation experiences, positive or negative, and ask for suggestions for improvement (if needed).

The study found that an increased use of digital tools on board ships is generally perceived as a positive development (e.g. increased personal safety, enhanced efficiency), but that attention needs to be given to a number of elements (e.g. risk of over-reliance, better training) to ensure the industry reaps all the benefits of these tools.

On a positive note, digital tools are seen by seafarers as having a positive impact on efficiency at work by reducing administrative burden and time spent on tasks, as well as allowing them to engage in more complex and high-level tasks. Seafarers also overwhelmingly believe that digital tools improve their personal safety on board, and a wide majority feel qualified to operate them. They are however less convinced that time saved leads to more rest time. They are also quite concerned about new risks (such as cyberthreats and malfunctions) created by the digitalisation of work tools.

The survey also shows that stakeholders are satisfied with the positive effect of increased digitalisation on personal safety on board, reducing errors, exposure to risk (e.g. to the properties of the cargo) and enabling seafarers to reduce physically challenging daily tasks. Stakeholders also believe digital tools reduce administrative burden, allowing seafarers to focus on other relevant tasks, in turn leading to a better optimisation of resources. Turning to elements that need improving, stakeholders are less positive about the adequacy of training provided to seafarers, highlighting that updated training is needed to re-skill and up-skill crew with digital skills.

Looking to the future, more than half of the seafarers believe that digitalisation will lead to a reduction in ship crew size, while a smaller share of stakeholders believes this will be the case. When asked the overarching question about whether the increased use of digital tools on board ships is a positive development, both seafarers and stakeholders mainly responded affirmatively.

In the analysis looking at the results of the survey per category of seafarers (by age, rank, type of ship) a number of trends appeared. It can be noted that the younger the seafarers, and the lower their rank, the more positive they are about digital tools. The younger generation of seafarers are

¹ <https://www.ecsa.eu/WESS>

² The term “safety” refers here to occupational safety/safety of the working environment of the seafarers

less concerned about new risks created by the digitalisation of work tools, and put more trust in these tools. Also, considering the results of the surveys based on ship type, a difference of opinion appeared between those sailing on cruise vessels and tankers (overall relatively positive about digital tools), and those sailing on ferries (much less enthusiastic about digital tools). The seafarers working on board ferries are also the ones who most firmly take the view that digitalisation will lead to a reduction in ship crew size and move more tasks on-shore.

Building on these results, the following recommendations are made:

1. Ensure that all tools are suited for on board use, by involving seafarers in the decision-making process, ideally at the stage of tool development and calibration
2. Give special attention to the user-friendliness of tools, and prefer tools with built-in familiarisation training modules or user manuals
3. Ensure that tools are properly tested and refined before full rollout
4. Avoid double tasking/reporting (paperwork + digital procedure) by decreasing, wherever possible, traditional paperwork
5. Ensure continuous updated training to re-skill/up-skill crew
6. Adapt seafarer training in maritime schools to the digital reality, while maintaining traditional seafarer training (to avoid loss of essential skills and practical seamanship)
7. Be cautious of over-reliance/trust in digital tools (ashore and on board) and stress importance of human cross-check and oversight
8. Be mindful of differences in level of familiarity with digital tools on board (depending on level of experience/training) and adapt training accordingly to avoid some seafarers being left behind
9. Ensure that new risks created by increased use of digital tools (e.g. cybersecurity risks) are appropriately taken into consideration, and reassure/inform seafarers of measures taken to minimise risks (e.g. training, manual override protocols)
10. Carefully consider the burden of responsibility when digital tools result in a shift of tasks from ship to shore. Responsibility should follow the task
11. Be mindful of isolation of crew members – ensure that opportunities remain on board for seafarers to socialize together where they wish to do so
12. Ensure that advances in digitalisation also provide benefits for seafarers, e.g. in the form of improved possibilities to communicate with family and friends
13. Remote inspections - only to be used when physical inspections are not possible

2. Introduction

In the context of the EU co-funded WESS project³, ECSA and ETF are committed to assessing shipboard living and working conditions with a view to taking action to contribute to an “attractive, smart and sustainable environment onboard”. As part of this project, they have commissioned ADS Insight to carry out research to investigate the increased use of digitalisation on board and possible benefits/improvements to shipboard safety⁴ and welfare. This research was carried out in close collaboration with their joint working group on Health and Safety (acting as ECSA/ETF Project Steering Group 1 - PSG1). The project ran from January 2021 to February 2022.

3. Methodology

Desk research and literature review

The starting point of the research was a desk-based exercise to map out and analyse existing research findings⁵. This provided an informed overview of the current state of play and trends on the impact of increased digitalisation in the maritime sector. The desk research also served to guide the survey process by ensuring that information collected included issues that may not have been sufficiently explored by past studies/research.

Surveys

To get detailed insights as regards life on board, and the impact of increased digitalisation, the cornerstone of the research entailed reaching out to those with firsthand experience through online surveys. These surveys were circulated to a wide audience to gain a broad range of insights. The aim was to hear about digitalisation experiences, positive or negative, and ask for suggestions for improvement (if needed).

Two surveys were developed and circulated. They were sent to:

1. Individual seafarers: the views of individual seafarers created value by collecting unfiltered insights and experiences directly from seafarers, who are witnessing the impact of increased digitalisation on the profession in their day-to-day work. Responses were received from 791 seafarers.
2. Companies/ interest representatives: this input has provided insights into the points of view of companies and groupings of interest representatives, who may be expected to have a broader, but also more strategic approach to the matter. Feedback from 46 entities was collected. In this research we have referred to these respondents as “stakeholders”.

³ <https://www.ecsa.eu/WESS>

⁴ The term “safety” refers here to occupational safety/safety of the working environment of the seafarers

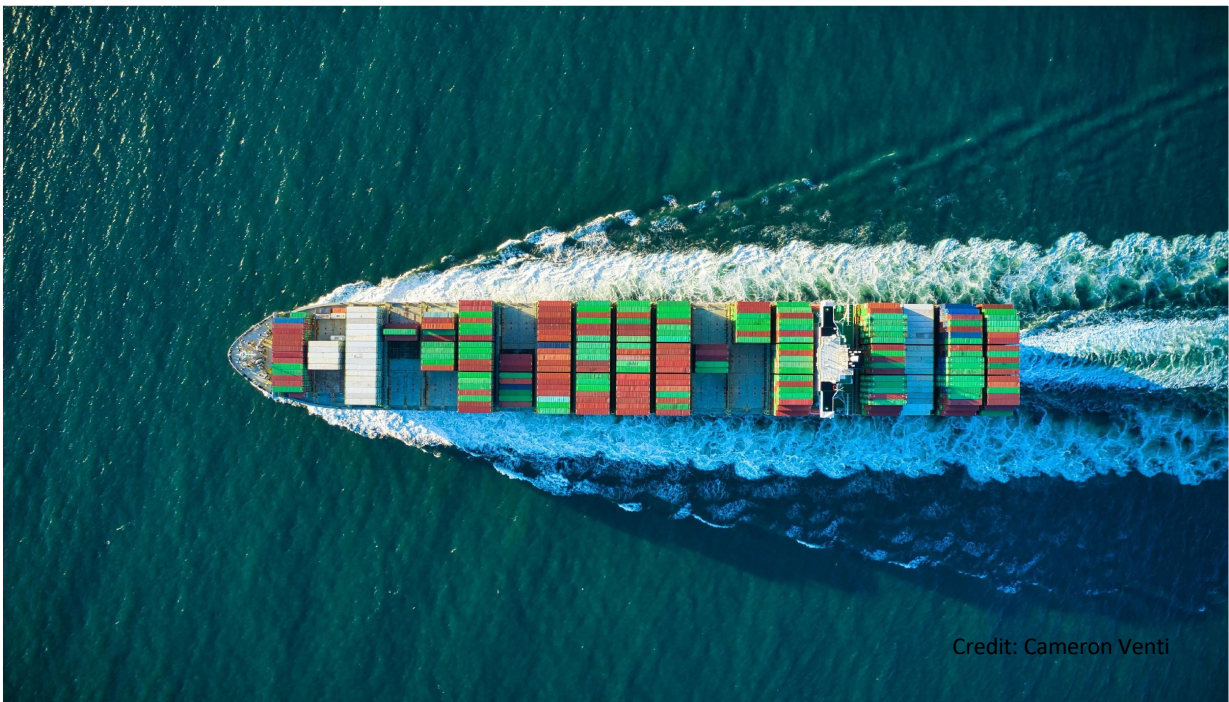
⁵ See bibliography in Annex 1

These surveys allowed to build a comprehensive picture of how life on board ships is impacted by the increased use of digital tools. Respondents shared their thoughts on how these tools impact their daily work, what they see as the main benefits/drawbacks, and gave a few hints as to how things could be improved.

In more detail, the surveys were structured as follows:

- Part 1 - questions to learn about the respondents' profile (e.g. organisation, age, rank, ship type): collecting this type of information enabled a cross-tabulation analysis, whereby the opinions of specific subgroups of respondents could be drawn out
- Part 2 - statements to which respondents were invited to agree/disagree with, with the additional possibility to provide comments (stakeholders' responses are presented in separate framed boxes in the section 4.2 of this report)
- Part 3 - open-ended questions

Based on the results of the surveys, a number of findings are presented (section 4), followed by a set of conclusions (section 5) and recommendations (section 6). This report highlights the key findings from the data collected. A more detailed set of data collected through the surveys is included in Annex 2.



4. Literature review

The automation of seafaring activities has been discussed at international level since the early 1960s, including its impact on the profession. The present survey, however, is limited to the more recent type of automation/digitalisation, where technology not only assists the crew in performing their tasks, but even may replace crew members in carrying out certain functions. The interest in this development has increased significantly in the past years, not least through the attention given to Maritime Autonomous Surface Ships (MASS) at the International Maritime Organization (IMO) in this period.

The impact of technology on the design of onboard spaces, including bridge and engine department, has received considerable attention in scientific literature (e.g. Alop, 2019, Babica et al. 2020, Costa 2018, T. Relling et al, 2018, Lundh et al. 2011) as have the development's impact on employment (Kitada et al. 2019, Jo & D'Agostini 2020) and new training needs and methods (e.g. Baldauf et al., 2018, Suresh, 2019).

The social impact of digitalisation has received less attention. However, the HSBA study on Seafarers and digital disruption (HSBA, 2018) and the 2019 World Maritime University's *Transport 2040: Automation, Technology, Employment - The Future of Work* (WMU, 2019) represents recent examples of research that touches upon these issues. The recent study carried out for the European Commission on social aspects within the maritime sector (EC, 2020) covers a broad range of issues, including digitalisation.

Certain large-scale interview-based studies with seafarers about their opinions on certain aspects of technological development have also been undertaken, both internationally (Nautilus Federation 2016 and 2018) and nationally (e.g. Jo et al, 2020).

These studies highlight the continued need for – and relevance of - seafarers on board ships in the foreseeable future, but also the challenges for the work that digitalisation entails. A certain ambivalence characterises the assessment of the impact of digitalisation. Several risks for seafarers are identified, including technically demanding new tasks, safety concerns and increased loneliness and boredom. On the other hand, the studies also acknowledge that the technological developments entail opportunities and potential benefits for seafarers, including in the form of increased connectivity and remote operations, increased safety, and more job satisfaction.

5. Key-findings

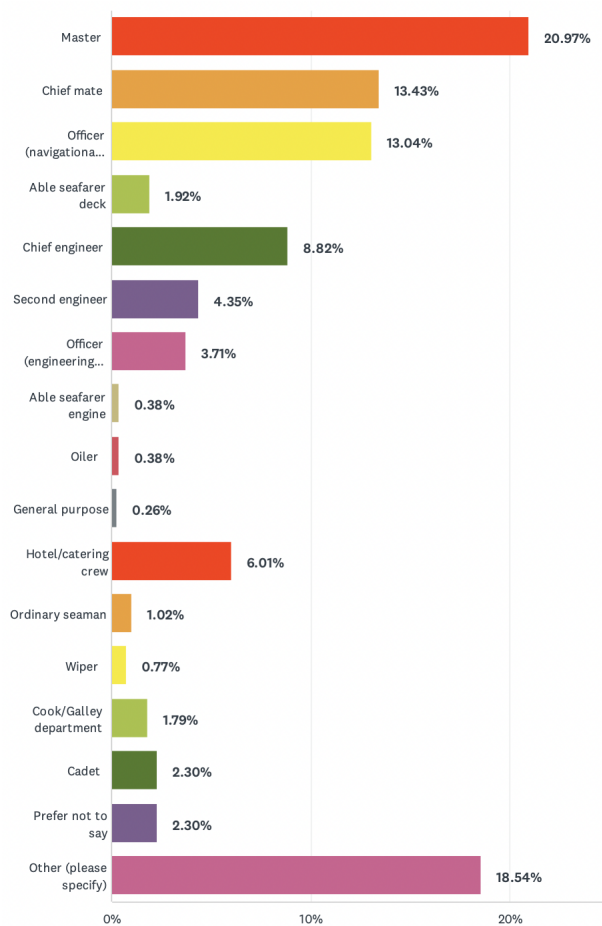
5.1. Profile of respondents

Seafarers

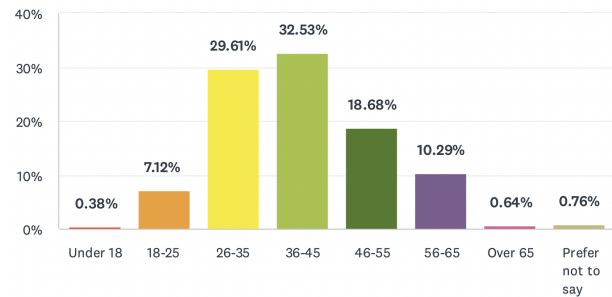
A total of 791 seafarers responded to the survey. The “average” seafarer who responded has sound experience working on board, is of mid-age (around 40 years), male, with a relatively high rank, sails worldwide and uses a variety of digital tools. The ship is relatively new (less than 15 years old) and is a cruise ship/container ship/tanker, therefore a rather large and complex vessel.

More information on the profile of respondents can be found in the following graphs.

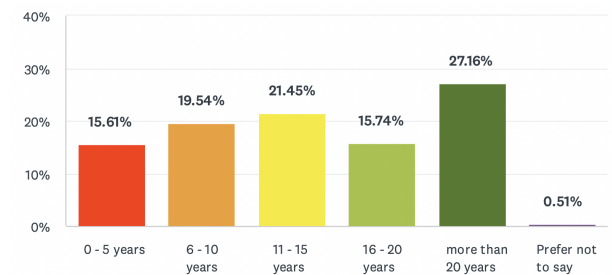
Seafarers' rank



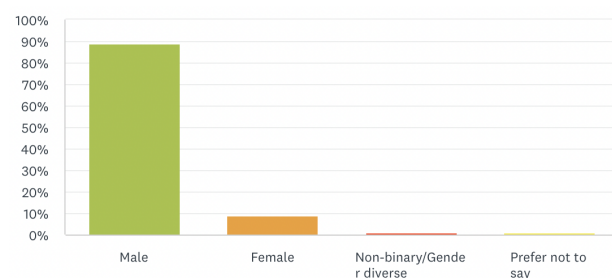
Seafarer's age



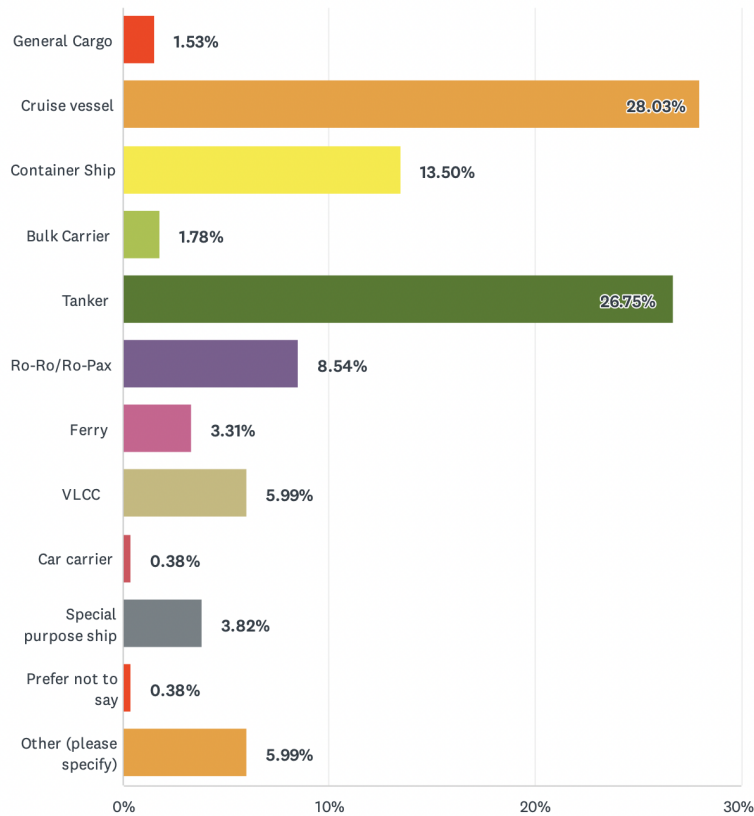
Years of seagoing practice



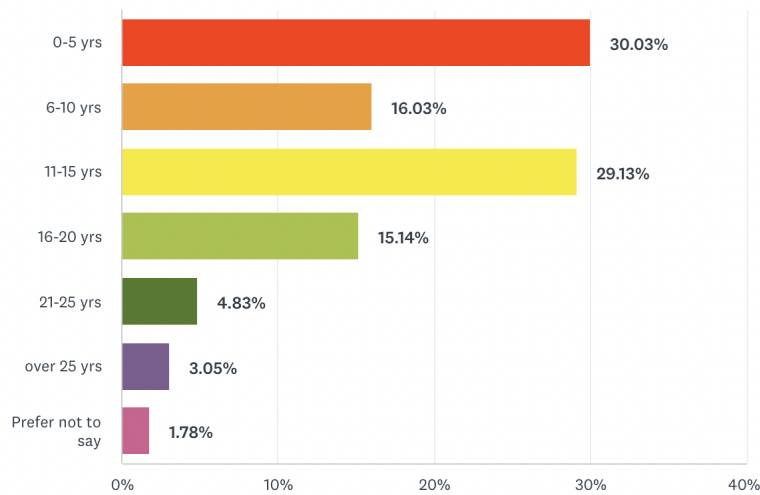
Gender



Ship type



Age of ship sailed



Companies/interest representatives (“stakeholders”)

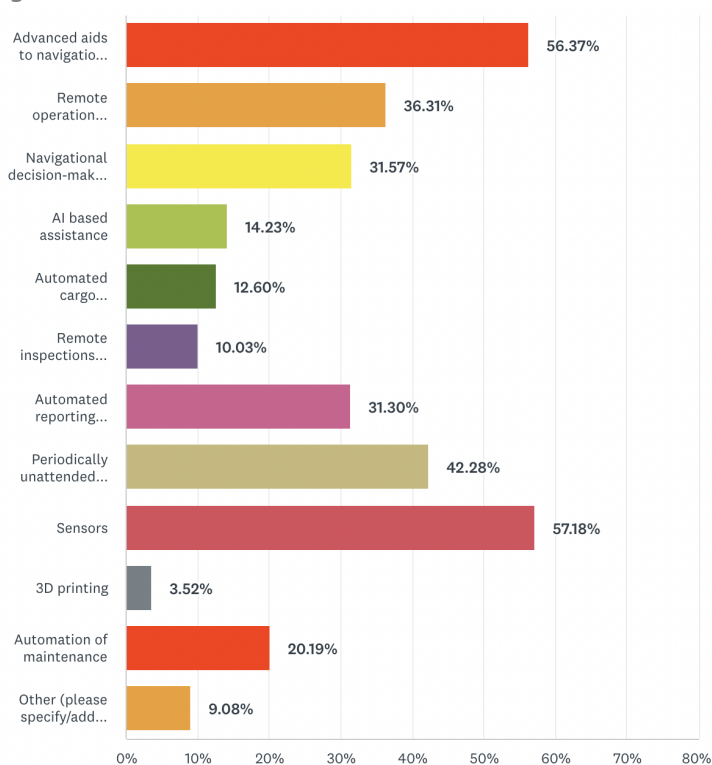
A total of 46 entities responded to the survey. The respondents included mainly individual companies, but also a few interest organisations⁶.

⁶ The list of respondents (who included their names) can be found in Annex 2

Type of tools used by respondents

Respondents were asked at the beginning of the survey to indicate what type of digital tools were most commonly used on board the ships they operate/their ships. The graph below provides an overview of the replies, showing that a wide range of tools are being used⁷. Advanced aids to navigation (dynamic positioning systems, integrated navigation systems) and sensors were most frequently mentioned.

Digital tools used on board



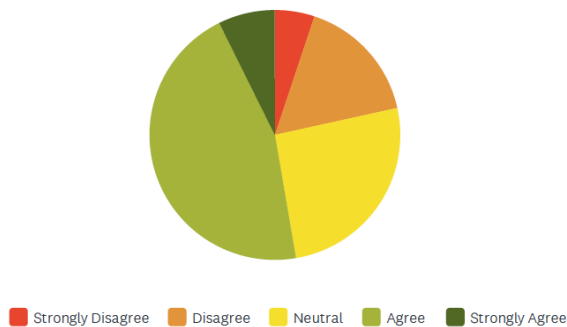
⁷ 1) Advanced aids to navigation (dynamic positioning systems, integrated navigation systems); 2) Remote operation technologies; 3) Navigational decision-making tools; 4) AI based assistance; 5) Automated cargo operations; 6) Remote inspections (e.g. cargo holds); 7) Automated reporting requirements/software tool (single window); 8) Periodically unattended machinery spaces; 9) Sensors; 10) 3D printing; 11) Automation of maintenance; 12) Other (please specify)

5.2. Responses to statement questions

Seafarers' digital experience and qualifications

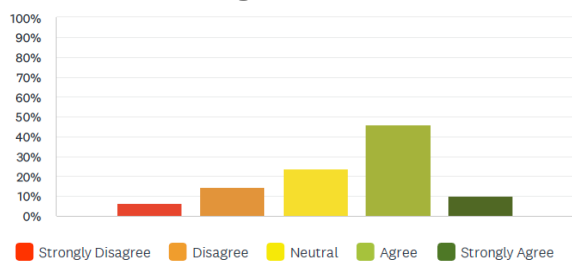
The survey asked seafarers about their experience with digital tools. **52% agree that digital tools are user-friendly and work as intended**, 26% remain neutral on this issue and around 22% either disagree or strongly disagree. Many add that the **functionality and reliability of the tools differ a lot from one to another**.

My experience with digital tools is that they are usually user-friendly and work as intended



Nevertheless, as many as **80% of seafarers feel that they are qualified to operate digital tools**. Less than 3% are of the view that they do not feel qualified to operate such tools. Seafarers underline that **proper training and user-friendly manuals or instructions are essential**. Over half of the seafarers consider that their employers invest sufficiently in training on this matter, while 21% disagree with the statement.

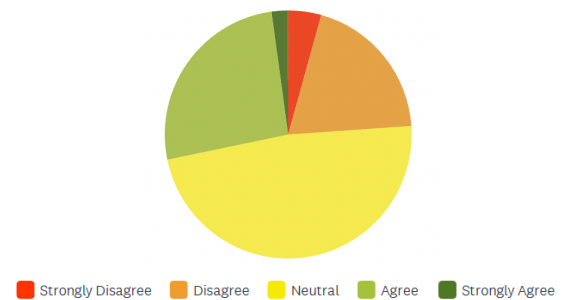
My employer invests sufficiently in training to allow me to use digital tools used on board



Stakeholders' point of view

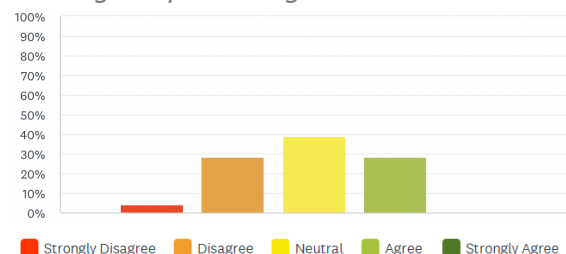
Interestingly, this part of the survey shows the biggest differences in perception between seafarers and stakeholders. **Only 28% of stakeholders agree that digital tools are user-friendly**, with 48% remaining neutral and 24% disagreeing. Stakeholders consider that **many digital tools used on board are still in a testing phase** and will become more user-friendly as they are refined.

Digital tools are usually user-friendly and work as intended



Stakeholders are also much less satisfied than seafarers with the level of training provided. Only 28% agree that seafarers receive adequate training, while 33% disagree with that and 39% remain neutral.

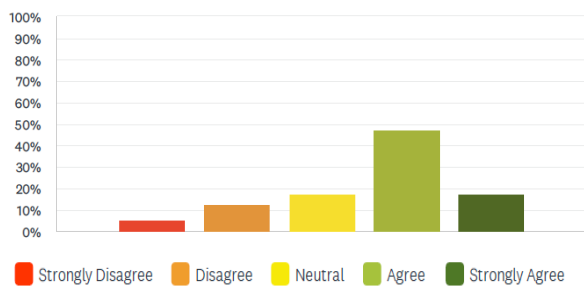
Seafarers are provided with adequate training to operate digital tools



Reduced administrative burden and better time management

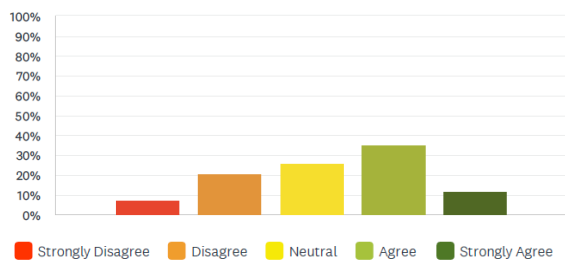
The survey clearly shows that **digital tools enhance the efficiency of work**. As many as 64% of seafarers consider that digital tools reduce their administrative burden as well as the time needed to carry out tasks. Those who disagree consider that in many cases the **use of digital tools does not replace pre-existing procedures**, but rather adds another layer to existing paperwork, especially for higher ranking seafarers. This, in their opinion, is caused, among others, by the reduced manning resulting from digitalisation.

Digital tools have reduced the time I need to carry out tasks



Another question is how this saved time is used. While over 63% of seafarers agree that **digital tools allow them to engage in more complex and high-level tasks (less repetitive)** only **46%** state that this results in more rest time for them.

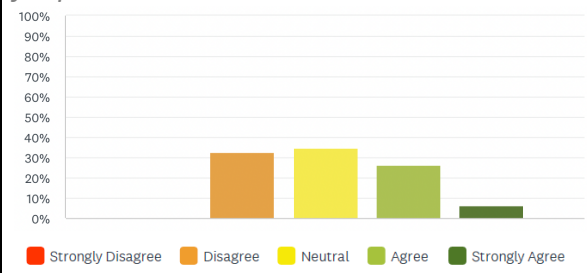
Digital tools allow me to have more rest time/time for personal use



Stakeholders' point of view

Broadly similar results follow from the stakeholders' responses: **69% perceive digital tools as reducing the administrative burden**, while 19% disagree with that. Stakeholders are however less optimistic as concerns seafarers' time for personal use. **Only 32,5% agree that digital tools have a positive impact offering seafarers more rest time**, while 32,5% disagree and 35% remain neutral on this issue.

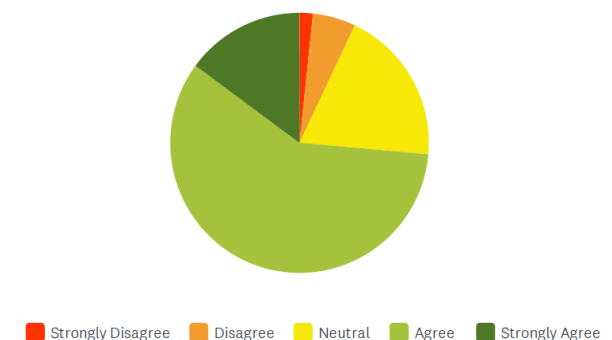
Digital tools allow for more rest time / time for personal use



Increased personal safety and trust

An overwhelming majority of seafarers (73%) agree that digital tools improve their personal safety on board, with only 7% disagreeing.

Digital tools improve my personal safety on board when fulfilling my duties



Their trust in the tools is somewhat more limited: 58% of the seafarers say that they trust in tools relying on digital technologies, while a large share of 32% remains neutral on the topic and 10% disagree. Seafarers underline that, **to be trustworthy, digital tools need correct configuration, regular maintenance and updates, and that human cross-check and oversight remain indispensable.**

Stakeholders' point of view

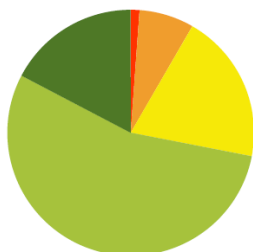
An even larger percentage (**82,5%**) of stakeholders believe that digital tools improve personal safety on board with only 9% disagreeing.

Meanwhile, half of the stakeholders agree that tools relying on digital technologies are trustworthy while 28% remain neutral and 22% disagree.

Looking to the future

72% of seafarers are concerned about new risks (such as cyberthreats, digital equipment malfunctions) created by the digitalisation of work tools. Some of the preventive measures that they see are: **better staff training and availability of manual override protocols** in case of failure.

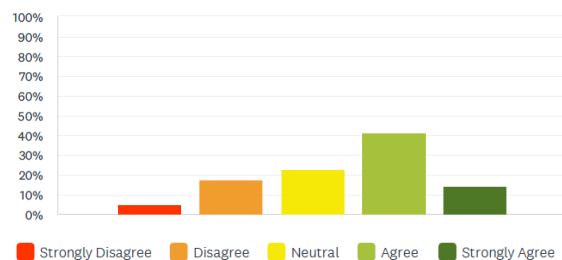
I am concerned about new risks created by the digitalisation of work tools



Strongly Disagree Disagree Neutral Agree Strongly Agree

Furthermore, 76% of the seafarers consider that **digital tools will fundamentally change their work in the next 10 years.** More specifically, **55,5% believe that digitalisation will lead to a reduction in ships' crew size,** with 22% disagreeing and 22,5% remaining neutral on the topic. Those who disagree, comment that in maritime transport there will always remain **tasks that need to be carried out on board by crew and cannot be digitalised.**

I believe that digitalisation will lead to a reduction in ship crew size

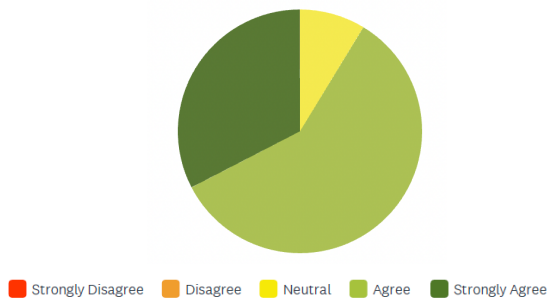


Turning to the possible shift from ship to shore, half of the seafarers agree that digitalisation may potentially move more tasks and responsibilities on-shore. 23% disagree and 27% remain neutral. Here, too, seafarers comment that, **even if certain tasks move on-shore, most will still be carried out on board** and therefore the responsibility for these tasks will stay on board with the crew.

Stakeholders' point of view

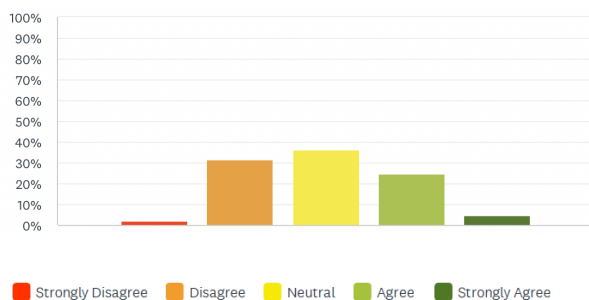
As concerns the future impact of digitalisation, as many as **91% of surveyed stakeholders agree that digitalisation creates new risks** (compared to 72% for seafarers).

Digitalisation of work tools create new risks



A majority of stakeholders (74%) consider that digital tools will change the work of seafarers in the next decade. However, they foresee a lesser effect on changes in ship crew size. **Only 29% agree that digitalisation will lead to a reduction in ship crew size** (compared to 55% for seafarers) while 34% disagree with that statement.

Digitalisation will lead to a reduction in ship crew size



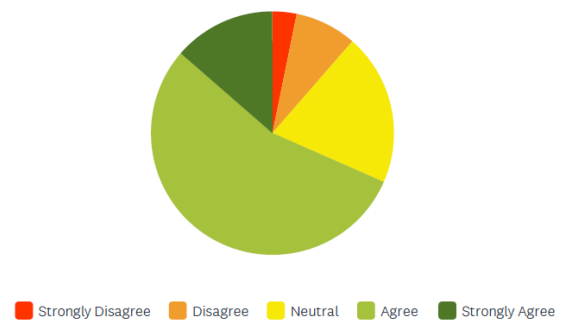
In addition, 58,5% of the stakeholders believe that digitalisation would move more tasks on-shore.

Conclusion: digital tools are a positive development

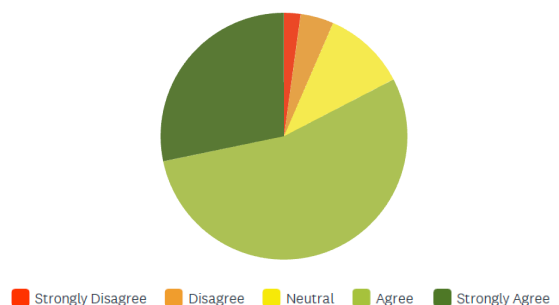
Overall, **68% of seafarers agree that an increased use of digital tools on board ships is a positive development while only 11% disagree**. Seafarers comment that such tools are a positive development as long as they are correctly designed and used. Nevertheless, they underline that **there will always remain a need for human oversight**.

An even bigger share of surveyed stakeholders (82,5%) agrees that an increased use of digital tools on board ships is a positive development while only 6,5% disagree with that statement.

Seafarers



Stakeholders



5.3. Cross-tabulation analysis

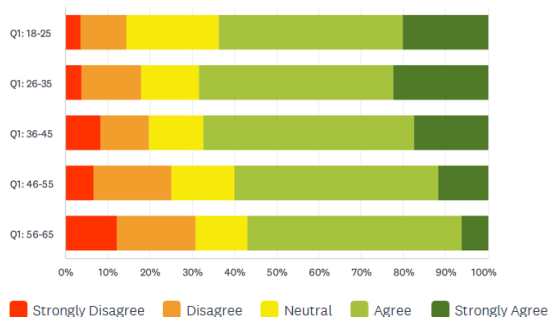
This section looks at the different categories of seafarers and how they have responded to the survey questions. Three different cross-tabulations have been performed:

1. Per age
2. Per rank
3. Per ship type

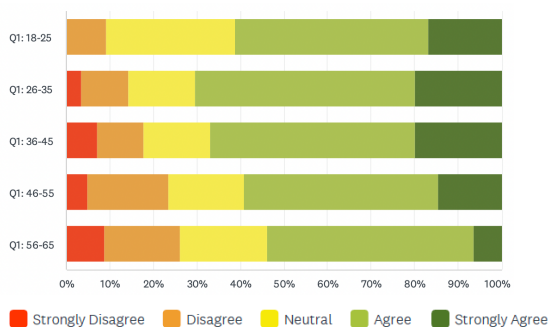
By age of seafarers

Considering the results of the survey overall, it can be noted that **the younger the seafarers, the more positive they are about digital tools**. To highlight a few examples, a majority of seafarers aged 26-35 is confident that digital tools reduce administrative burden, reduce time spent on tasks and allow them to carry out more complex tasks. Those aged 46-55 and 56-65 are slightly more reserved.

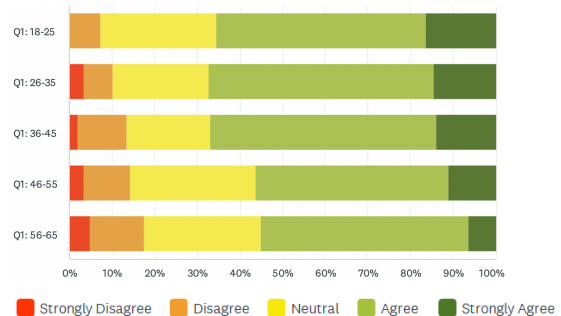
Digital tools reduce administrative burden



Digital tools have reduced the time I need to carry out tasks

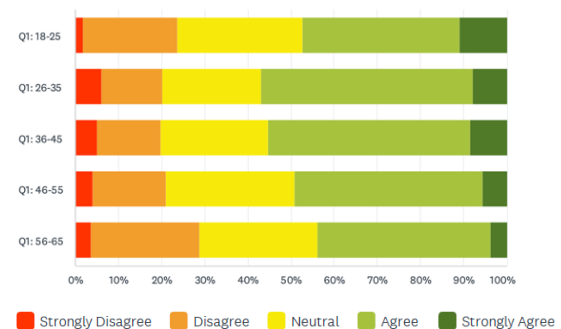


Digital tools allow me to engage in more complex and high-level tasks



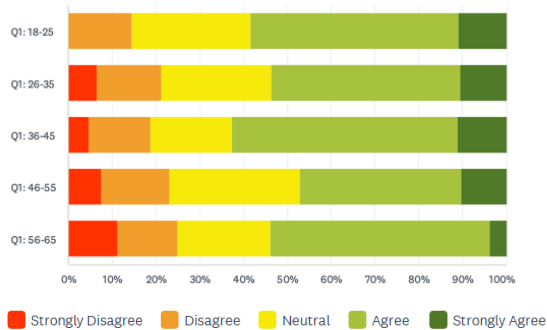
The difference of opinion between younger/older seafarers is however less present when asked whether digital tools are user-friendly. Here the opinions of the youngest seafarers echo those of the more senior ones.

Digital tools are usually user-friendly and work as intended



It is also interesting to note that **the older seafarers (aged 56-65) are those who are least satisfied with the amount of training on the use of digital tools offered by employers.** 25% of those in the 56-65 age bracket disagree that training is sufficient. This **older generation of seafarers is also the category that feels least qualified to operate digital tools**, albeit that the differences are not very big in this regard.

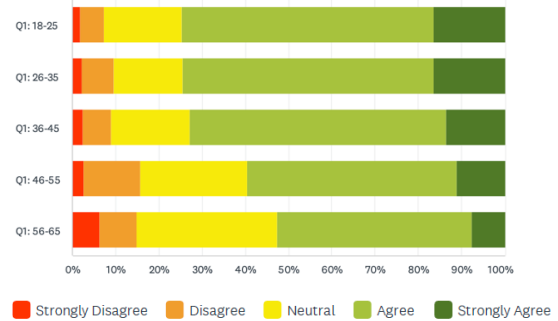
My employer invests sufficiently in training to allow me to use digital tools used on board



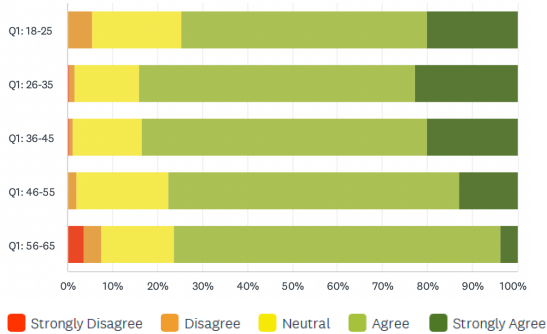
Similarly, turning to occupational safety, the **seafarers in the higher age groups are less convinced that digital tools improve their personal safety on board.**

Finally, in response to the overall statement that digital tools are a positive development, we can see the slight difference of opinion between the younger generation of seafarers and the older one. Seafarers in the higher age groups are less positive about such developments.

An increased use of digital tools on board ships is a positive development



I feel qualified to operate digital tools

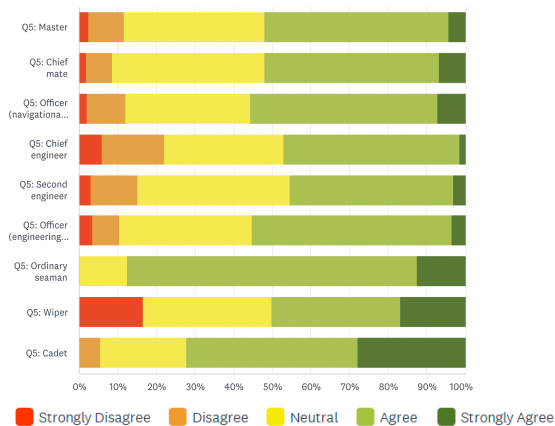


By rank of seafarers

When assessing the responses of seafarers per rank, some interesting observations could be made by more specifically limiting the analysis to the responses from higher ranks (e.g. Master, Chief mate) compared to the responses from lower ranks (e.g. Ordinary Seaman and Wiper) and cadets.

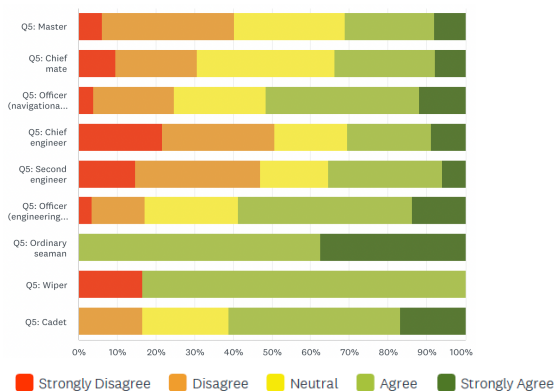
Here, it can be noted that **the lower ranks' level of trust in digital tools is greater than that of more senior seafarers, and that cadets/ordinary seamen are least concerned about the new risks created by the digitalisation of work tools.**

I trust in tools relying on digital technologies



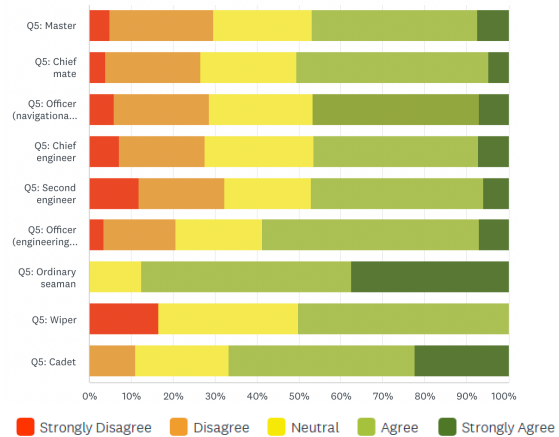
Lower ranking seafarers are also more likely to think that digital tools allow them to have more rest time/time for personal use.

Digital tools allow me to have more rest time/time for personal use

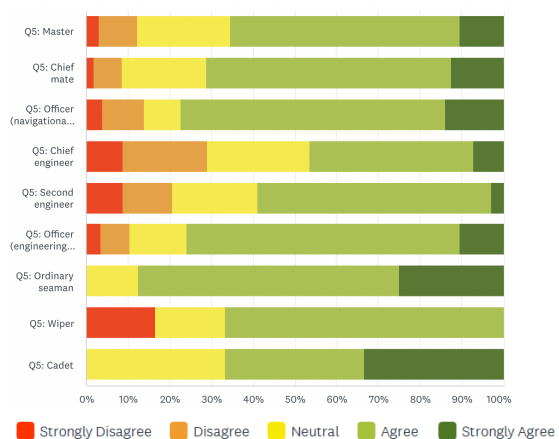


Furthermore, even though most cadets (66%) and ordinary seamen (87,5%) agree that increased digitalisation would move more tasks on-shore and that it would lead to a reduction in ship crew size (61% and 87,5%), they nevertheless overwhelmingly consider (66% and 87,5%) that the **use of digital tools on board ships is a positive development.**

Increased digitalisation would move more tasks/responsibilities on-shore



An increased use of digital tools on board ships is a positive development

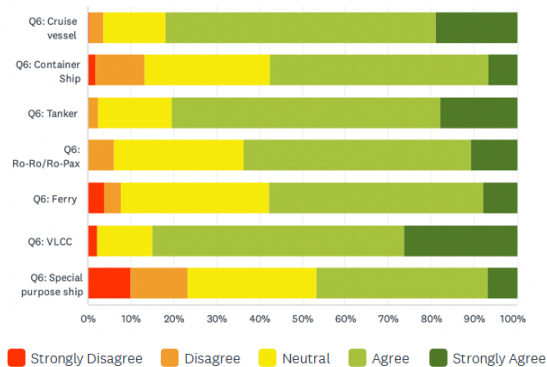


Moreover, cadets are less convinced than other categories that digital tools will fundamentally change the work of seafarers in the next 10 years. Over 27% of them disagree with that, compared to e.g. 5% of masters and 5% of chief mates.

By ship type

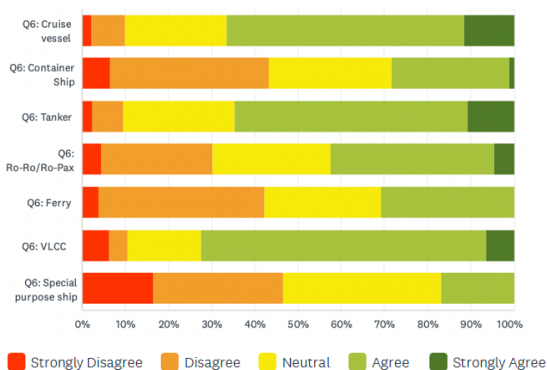
Seafarers sailing on cruise vessels and tankers stand out as being overwhelmingly positive about digital tools used on board ships. They trust in tools relying on digital technologies and agree that such tools improve their personal safety. This is less prevalent for their colleagues sailing on container ships, Ro-Ro/Ro-Pax, ferries and special purpose ships.

Digital tools improve my personal safety on board when fulfilling my duties



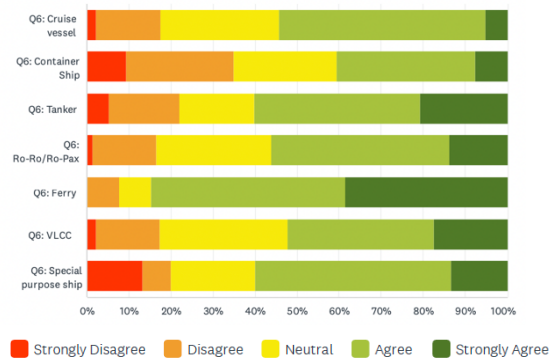
Similarly, compared to other ship types, a much larger share of the seafarers working on cruise ships and tankers agrees that digital tools reduce the administrative burden, allowing for more rest time, and that they are user-friendly.

Digital tools are usually user-friendly and work as intended



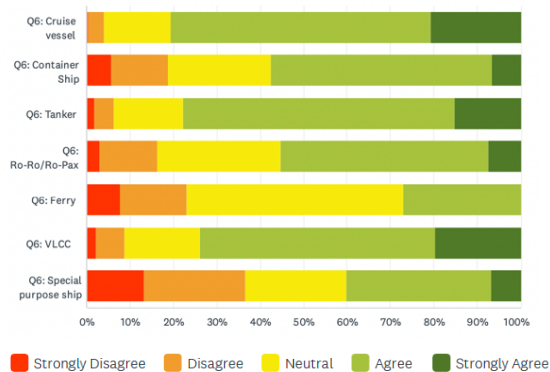
Another group that stands out are the seafarers working on ferries. Compared to other categories, they clearly take the view that digitalisation will lead to a reduction in ship crew size (84%) and move more tasks on-shore (61%).

I believe that digitalisation will lead to a reduction in ship crew size



However, comparatively few among the seafarers working on ferries (27%) perceive the increased use of digital tools on board ships as a positive development.

An increased use of digital tools on board ships is a positive development



5.4. Open-ended questions

To complement the answers to the statement questions, optional open-ended questions were included in the surveys. This allowed respondents to give wider feedback, adding more nuances to what they could reply to the “agree/disagree” statement questions. The elements drawn out of these open-ended replies matched the trends identified in the analysis of the data from the more restricted statement questions.

Biggest benefit of increased digitalisation on board

Seafarers

When asked about the biggest benefit of increased use of digital tools on board, many seafarers referred to the time saved in carrying out tasks, and the simplification of tasks. Other benefits raised included improved accuracy, less risk of human error, reduced workload, less paperwork, help in decision making, and reduced mundane tasks. While the question was directed towards the benefit of digital tools for work (and not for personal use), many respondents nevertheless highlighted that they saw digital tools as giving access to families, perceived as a very valuable benefit. Interestingly, some saw the reduction of human contact thanks to digital tools as a positive development, reducing the risk of COVID-19 contamination (hopefully, only a temporary perceived benefit). Remote medical inspections made possible by digital tools were also mentioned.

Stakeholders

When asked about the most positive elements of increased digitalisation on board, stakeholders mentioned the reduction in the exposure to risk, e.g. reduced physical exposure to the properties of cargoes, but also allowing daily tasks to be less physically challenging for seafarers. Such tools are also seen as reducing the administrative workload on board and enabling crew to focus on other relevant tasks, in turn leading to less stress for seafarers. Stakeholders also pointed towards efficiency gains, better optimisation of resources, and a reduction of errors. Some respondents further mentioned that digital tools allow enhanced control of vessels and crew performance (“full overview from the main office”) and give access to trends and statistics as a basis for decisions. More streamlined information and better communication between shore and vessel were also highlighted. Digital analytical tools are also seen as giving the opportunity to be more proactive in improving safety.

Negative impacts of increased digitalisation on board

Seafarers

A significant number of seafarers was concerned about the lack of human interaction and face-to-face contact as a consequence of the increased digitalisation of work on board. Many mentioned that digital tools decreased socialising, with some pointing to the fact that this has a negative impact on mental wellbeing. As this survey was carried out during the COVID-19 pandemic, when seafarers were dealing with very isolating conditions, this could have also exacerbated this feeling. Another negative issue raised was the stress and anxiety created by malfunctioning digital tools. Time spent troubleshooting and double-checking is seen as undermining some of the positive effects of digitalisation. Respondents also said that increased reliance on digital tools was leading to a reduced situational awareness and increased

complacency, particularly with regard to the younger generation of seafarers. They give examples, such as spending more time looking at screens instead of carrying out watchkeeping duties. Some see digital tools as distracting the crew from performing more important tasks. In the same vein, many point out that over-reliance and trust in digital tools means that some crew members do not know how to react in case of failure of these tools. They imply a loss of essential skills such as human intuition and practical seamanship. Some also feel that increased digitalisation means less crew on board, leading to a feeling that their jobs are being taken over by machines.

Stakeholders

Stakeholders also highlighted the risk of over-reliance on digital tools, leading to a false sense of security and a loss of situational awareness and basic seamanship (e.g. with digital charts). They also feel that digital tools create “barriers” between the machinery/operations and the seafarer. In the same line of thought, some respondents noted that a lack of understanding of how the tools work and what the tools are doing on their behalf (regarding Artificial Intelligence in particular), leads to “compelled” blind trust. Stakeholders also said that some crew members who are less at ease with the use of digital tools (seafarers in the higher age groups) risked feeling left behind, and that they needed to learn new digital skills could result in increased stress. In addition, traditional seafarer training is perceived as not being adapted to the increased use of digital tools on board. Isolation of individuals, and the reduced physical social interaction on board were also pointed out as negative impacts. Finally, some respondents raised the fact that more digitalisation on board could lead to crew feeling that the management does not trust them (to carry out tasks taken over by digital means). A perceived loss of responsibility from senior officers was also highlighted. Finally, cyber risks associated with the tools were mentioned as a concern.

How to alleviate risks in the future

Seafarers

A clear majority of respondents believe that risks can be alleviated in the future by updated training. According to respondents, this training should be done ashore by maritime schools, but also throughout the seafarers’ career. Continuous training is considered key to ensuring that the crew is up to date with the latest technologies, but also the associated risks (e.g. cyberthreats). Crews should not only receive one-off courses, but be given the chance for continuous learning opportunities. Better familiarisation with the digital tools is also believed to decrease the “fear of the unknown”. A number of respondents also pointed out that crew members needed to understand the purpose and benefits of the tools they are asked to use on a daily basis. Some also suggested that companies should consult with on board staff before investing in a certain type of tool, to ask for feedback about which tool would be most useful. Digital tools should furthermore be properly tested before being installed on board, e.g. to ensure user-friendliness. Respondents also called for a harmonisation of tools, avoiding having different tools on different ships. Overall, respondents felt that being confident with the use of digital tools through adequate training and familiarisation with the tools, would help to alleviate the identified risks.

Stakeholders

One issue that recurred in several responses from stakeholders was the need to ensure the crew understands what the tools they are asked to operate are doing, and what their benefits are. An interesting piece of advice given was: “Stop. Think. Click”. Training was also seen as a key tool to

alleviate risks associated with an increased digitalisation on board, along with including users in the choice of tools.

Effects of an increased use of digital tools during COVID-19 (e.g. remote inspections)

Seafarers

Within the context of the ongoing pandemic, many respondents perceive the increased use of remote inspections as having a negative effect on crews. Many highlight that it has created more workload for crews, with them having to scan many documents to send via email. They make the point that this has led to increased fatigue on board. Some also say that reduced contact due to remote inspections has created a sense of isolation on board, leading to related psychological issues. As an example, one respondent said this meant less “friendship between the office and the seafarers”, another said it made crews on ships “faceless”. Many respondents expressed a preference for physical inspections on board. They suggested that digital tools should be seen as an “aid” and not a controlling measure. A positive impact of an increased use of digital tools during the pandemic highlighted by some respondents was the reduced risk of contamination through less contact with external people. Some also pointed to the usefulness of digital tools as a whole during the pandemic, e.g. enabling shipping operations to continue.

Stakeholders

A general consensus clearly emerged in the replies from stakeholders, mainly reacting to the increased use of remote inspections during the pandemic. While such inspections are deemed useful and can be used on an occasional basis, a majority of stakeholders agreed that they should not fully replace physical on-board inspections.

Reasons given for using remote inspections only on an exceptional basis include:

- They increase workload for those on board, e.g. they have to send many documents to the inspectors in advance;
- They can have negative impact on safety and well-being on board;
- Increased distance between management and crew;
- Lack of face-to-face and informal discussions.

6. Conclusions

This report studied the effects of an increased use of digitalisation on board and considered possible benefits and improvements regarding shipboard safety and welfare. Based on the wide input collected, it was found that **an increased use of digital tools on board ships is generally perceived as a positive development** (e.g. increased personal safety, enhanced efficiency), **but that attention needs to be given to a number of elements** (e.g. risk of over-reliance, better training) **to ensure the industry reaps all the benefits of these tools.**

On a positive note, digital tools are seen by seafarers as improving efficiency at work by reducing administrative burden and time spent on tasks, as well as allowing them to engage in more complex and high-level tasks. They also overwhelmingly believe that digital tools improve their personal safety on board, and a wide majority feel qualified to operate them. Seafarers are however less convinced that time saved leads to more rest time. They are also quite concerned about new risks (such as cyberthreats and malfunctions) created by the digitalisation of work tools.

The research also shows that stakeholders are satisfied with the positive effect of increased digitalisation on personal safety on board, reducing errors, exposure to risk (e.g. to the properties of the cargo) and enabling seafarers to reduce physically challenging daily tasks. Stakeholders also believe digital tools reduce administrative burden, allowing seafarers to focus on other relevant tasks, in turn leading to a better optimisation of resources.

A few differences of opinion can be noted between seafarers and stakeholders. While approximately half of the seafarers believe that digital tools are user-friendly and work as intended, a much smaller share of stakeholders agree with this. Stakeholders commented that many digital tools used on board are still in a testing phase and will become more user-friendly as they are refined. Also, while half of the seafarers agree that their employer invests sufficiently in training, stakeholders are less positive about the adequacy of training provided to seafarers, highlighting that updated training is needed to re-skill and up-skill crew with digital skills. Looking to the future, a bit more than half of surveyed seafarers believe that digitalisation will lead to a reduction in ship crew size, while a smaller number of stakeholders believe this will be the case.

Importantly, as highlighted above, the opinions of seafarers and stakeholders surveyed converge on the positive impact of digital tools on personal safety on board, and on the fact that such tools can reduce the administrative burden. Both categories of respondents also agree on the small impact of digitalisation on leading to more rest time, and on the need to be cautious about new risks related to a more digitalised environment (this concern is however notably higher among stakeholders). When asked the overarching question about whether the increased use of digital tools on board ships is a positive development, both seafarers and stakeholders mainly responded affirmatively.

In the analysis looking at the results of the survey per category of seafarers (by age, rank, type of ship) a number of trends appeared. In general, the younger the seafarers and the lower the rank, the more positive they are about digital tools. The younger generation of seafarers is less concerned about new risks created by the digitalisation of work tools and have more trust in these tools. Also, looking at the results of the surveys based on ship type, a difference of opinion appeared between those sailing on cruise vessels and tankers (overall relatively positive about digital tools), and those sailing on ferries (much less enthusiastic about digital tools). The ferry crew members are also the

ones who most clearly consider that digitalisation will lead to a reduction in ships' crew size and move more tasks to shore.

7. Recommendations

Building on the results of the research, the following recommendations are made:

1. Ensure that all tools are suited for on board use, by involving seafarers in the decision-making process, ideally at the stage of tool development and calibration
2. Give special attention to the user-friendliness of tools, and prefer tools with built-in familiarisation training modules or user manuals
3. Ensure that tools are properly tested and refined before full rollout
4. Avoid double tasking/reporting (paperwork + digital procedure) by decreasing, wherever possible, traditional paperwork
5. Ensure continuous updated training to re-skill/up-skill crew
6. Adapt seafarer training in maritime schools to the digital reality, while maintaining traditional seafarer training (to avoid loss of essential skills and practical seamanship)
7. Be cautious of over-reliance/trust in digital tools (ashore and on board) and stress importance of human cross-check and oversight
8. Be mindful of differences in level of familiarity with digital tools on board (depending on level of experience/training) and adapt training accordingly to avoid some seafarers being left behind
9. Ensure that new risks associated with increased use of digital tools (e.g. cybersecurity risks) are appropriately taken into consideration, and reassure/inform seafarers of measures taken to minimise risks (e.g. training, manual override protocols)
10. Carefully consider the burden of responsibility when digital tools result in a shift of tasks from ship to shore. Responsibility should follow the task
11. Be mindful of isolation of crew members – ensure that opportunities remain on board for seafarers to socialize together where they wish to do so
12. Ensure that advances in digitalization also provide benefits for seafarers, e.g. in the form of improved possibilities to communicate with family and friends
13. Remote inspections - only to be used when physical inspections are not possible



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Annex 2 – Survey data

Seafarers’ survey – detailed results

Question				
Answer Choices	Responses (%)	Responses (No)	Answered	Skipped
Q1. Age				
Under 18	0,38%	3		
18-25	7,12%	56		
26-35	29,61%	233		
36-45	32,53%	256		
46-55	18,68%	147		
56-65	10,29%	81		
Over 65	0,64%	5		
Prefer not to say	0,76%	6		
			787	4
Q2. Gender				
Male	89,06%	700		
Female	9,03%	71		
Non-binary/Gender diverse	1,02%	8		
Prefer not to say	0,89%	7		
			786	5
Q3. Nationality				
Albania	0,1%	1		
Bangladesh	0,7%	5		
Belarus	0,1%	1		
Belgium	0,1%	1		
Bosnia Herzegovina	0,1%	1		
Bulgaria	0,4%	3		
Brazil	0,3%	2		
Croatia	0,7%	5		
Denmark	0,1%	1		
Ecuador	0,1%	1		
Egypt	0,1%	1		
Estonia	0,3%	2		

Finland	4%	27		
France	0,3%	2		
Germany	19%	126		
Greece	12%	81		
Guatemala	0,1%	1		
Honduras	0,7%	5		
India	5,2%	35		
Indonesia	1%	8		
Ireland	1%	8		
Israel	0,3%	2		
Italy	15%	102		
Japan	0,4%	3		
Kenya	0,1%	1		
Latvia	0,3%	2		
Mexico	0,1%	1		
Montenegro	0,7%	5		
Netherlands	0,3%	2		
Norway	6,1%	41		
Paraguay	0,1%	1		
Peru	0,4%	3		
Philippines	12%	84		
Poland	2,4%	16		
Portugal	0,4%	3		
Romania	3,3%	22		
Russia	0,1%	1		
Serbia	0,6%	4		
South Africa	0,1%	1		
Spain	0,1%	1		
Sweden	0,4%	3		
Switzerland	0,4%	3		
Taiwan	0,1%	1		
Turkey	0,4%	3		
Ukraine	2,2%	15		
United Kingdom	4,2%	28		

USA	0,1%	1		
			666	125
Q4. Years of sea-going practice				
0 - 5 years	15,61%	123		
6 - 10 years	19,54%	154		
11 - 15 years	21,45%	169		
16 - 20 years	15,74%	124		
more than 20 years	27,16%	214		
Prefer not to say	0,51%	4		
			788	3
Q5. Rank				
Master	20,97%	164		
Chief mate	13,43%	105		
Officer in charge of a navigational watch	13,04%	102		
Able seafarer deck	1,92%	15		
Chief engineer	8,82%	69		
Second engineer	4,35%	34		
Officer in charge of the engineering watch	3,71%	29		
Able seafarer engine	0,38%	3		
Oiler	0,38%	3		
General purpose	0,26%	2		
Hotel/catering crew	6,01%	47		
Ordinary seaman	1,02%	8		
Wiper	0,77%	6		
Cook/Galley department	1,79%	14		
Cadet	2,30%	18		
Prefer not to say	2,30%	18		
Other (please specify)	18,54%	145		
			782	9
Q6. Ship type (current ship of employment or, if none, most recent one)				
General Cargo	1,53%	12		
Cruise vessel	28,03%	220		
Container Ship	13,50%	106		
Bulk Carrier	1,78%	14		

Tanker	26,75%	210		
Ro-Ro/Ro-Pax	8,54%	67		
Ferry	3,31%	26		
VLCC	5,99%	47		
Car carrier	0,38%	3		
Special purpose ship	3,82%	30		
Prefer not to say	0,38%	3		
Other (please specify)	5,99%	47		
			785	6
Q7. Age of ship (current ship of employment or, if none, most recent one)				
0-5 yrs	30,03%	236		
6-10 yrs	16,03%	126		
11-15 yrs	29,13%	229		
16-20 yrs	15,14%	119		
21-25 yrs	4,83%	38		
over 25 yrs	3,05%	24		
Prefer not to say	1,78%	14		
			786	5
Q8. Energy source used by ship (current ship of employment or, if none, most recent one)				
Conventional fuel oil	93,58%	729		
Alternative energy source (e.g. batteries, renewables)	3,34%	26		
Other (please specify)	3,08%	24		
			779	12
Q9. Operating area				
Worldwide	51,78%	379		
Regional shipping - Europe - Mediterranean and Black Sea	15,03%	110		
Regional shipping - Europe - Atlantic	5,19%	38		
Regional shipping - Europe - North Sea	9,43%	69		
Regional shipping - Europe - Baltic	5,19%	38		
Regional shipping - Asia-Pacific	2,05%	15		
Regional shipping - Middle-East	2,19%	16		
Regional shipping - Americas	3,28%	24		
Regional shipping - Africa	0,41%	3		
Domestic shipping (please indicate in which country in text box below)	5,46%	40		

			732	59
Q10. What digital tools do you use on board? (multiple answers are possible)				
Advanced aids to navigation, such as dynamic positioning systems or integrated navigation systems	56,37%	416		
Remote operation technologies	36,31%	268		
Navigational decision-making tools	31,57%	233		
AI based assistance	14,23%	105		
Automated cargo operations	12,60%	93		
Remote inspections (e.g.cargo holds)	10,03%	74		
Automated reporting requirements/software tool (single window)	31,30%	231		
Periodically unattended machinery spaces	42,28%	312		
Sensors	57,18%	422		
3D printing	3,52%	26		
Automation of maintenance	20,19%	149		
Other (please specify/add comment)	9,08%	67		
			738	53

Q11. Digital tools improve my personal safety on board when fulfilling my duties (e.g. reducing accidents).											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
1,66%	13	5,36%	42	19,54%	153	58,62%	459	14,81%	116	783	8
Q12. Digital tools reduce administrative burden (e.g. filling in forms, keeping records, approvals).											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
6,88%	54	14,01%	110	14,27%	112	47,77%	375	17,07%	134	785	6
Q13. Digital tools allow me to engage in more complex and high-level tasks (and less repetitive/mundane)											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
3,07%	24	9,86%	77	23,56%	184	50,70%	396	12,80%	100	781	10
Q14. Digital tools have reduced the time I need to carry out tasks.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
5,39%	42	12,71%	99	17,33%	135	47,11%	367	17,46%	136	779	12
Q15. Digital tools allow me to have more rest time/time for personal use.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
7,18%	56	20,64%	161	25,90%	202	35,00%	273	11,28%	88	780	11
Q16. My experience with digital tools is that they are usually user-friendly and work as intended.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
5,11%	40	16,48%	129	25,80%	202	45,34%	355	7,28%	57	783	8

Q17. I trust in tools relying on digital technologies.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
2,45%	19	7,34%	57	32,56%	253	50,32%	391	7,34%	57	777	14
Q18. I feel qualified to operate digital tools.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
0,76%	6	2,04%	16	16,69%	131	62,55%	491	17,96%	141	785	6
Q19. My employer invests sufficiently in training to allow me to use digital tools used onboard.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
6,51%	51	14,54%	114	23,47%	184	45,54%	357	9,95%	78	784	7
Q20. I am concerned about new risks created by the digitalisation of work tools (cyberthreats, digital equipment malfunctions...).											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
1,15%	9	7,28%	57	19,67%	154	54,53%	427	17,37%	136	783	8
Q21. I believe that digitalisation will lead to a reduction in ship crew size.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
4,73%	37	17,52%	137	22,51%	176	40,79%	319	14,45%	113	782	9
Q22. Increased digitalisation would move more tasks/responsibilities on-shore (e.g. remote operations, engine oversight, etc...).											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
4,36%	34	18,46%	144	27,18%	212	43,21%	337	6,79%	53	780	11
Q23. Digital tools will fundamentally change the work of seafarers in the next 10 years											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
2,30%	18	7,03%	55	14,07%	110	52,69%	412	23,91%	187	782	9
Q24. Overall, an increased use of digital tools on board ships is a positive development.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
3,20%	25	8,18%	64	20,20%	158	54,86%	429	13,55%	106	782	9

Stakeholders' survey – detailed results

Q1. Entity							
				Responses (%)	Responses (No)	Answered	Skipped
Boeckmans Ship Management				2			
Brise Bereederungs GmbH + Co KG				1			
Carbofin SpA				1			

Compagnie Yeu Continent	1			
Dover Harbour Board	1			
Enesel Limited	1			
Euronav	1			
Excelerate Technical Management	1			
Exmar	1			
Foreningen Svenskjofart	1			
Grimaldi Deep Sea Spa	1			
ICS	1			
Intertanko	1			
Interorient Ship Management	2			
Lemissoler Navigation	1			
MSC Group	1			
Mutualista Azoreana Transportes Maritimos SA	1			
Olympic Subsea ASA	1			
PGS Geophysical AS	1			
Redri AB Alvtank	1			
Rederi AB Donsotank	1			
Sanco Shipping AS	1			
Shipping Company	1			
Siem Offshore	1			
Steermar Ship Management Services	1			
Tarbit	1			
Tarmac Marine	1			
Tarntank Ship Management AB	1			
TechnipFMC	1			
TWW Yacht Management	1			
UMS	1			
Wallenius Marine AB	2			
			35	11
Q2. What digital tools do you use on board? (multiple answers are possible)				
Advanced aids to navigation, such as dynamic positioning systems or integrated navigation systems	75,56%	34		
Remote operation technologies	37,78%	17		
Navigational decision-making tools	55,56%	25		

AI based assistance	8,89%	4		
Automated cargo operations	20,00%	9		
Remote inspections (e.g.cargo holds)	28,89%	13		
Automated reporting requirements/software tool (single window)	51,11%	23		
Periodically unattended machinery spaces	68,89%	31		
Sensors	53,33%	24		
3D printing	2,22%	1		
Automation of maintenance	24,44%	11		
Other (please specify/add comment)	8,89%	4		
			45	1

Q3. Digital tools improve personal safety on board (e.g. reducing accidents).											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
0,00%	0	8,70%	4	8,70%	4	63,04%	29	19,57%	9	46	0
Q4. Digital tools reduce administrative burden (e.g. filling in forms, keeping records, approvals).											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
2,17%	1	17,39%	8	10,87%	5	47,83%	22	21,74%	10	46	0
Q5. Digital tools allow seafarers to engage in more complex and high-level tasks (and less repetitive/mundane)											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
2,17%	1	23,91%	11	10,87%	5	50,00%	23	13,04%	6	46	0
Q6. Digital tools have reduced the time seafarers need to carry out tasks.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
2,22%	1	24,44%	11	15,56%	7	48,89%	22	8,89%	4	45	1
Q7. Digital tools allow for more rest time/time for personal use.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
0,00%	0	32,61%	15	34,78%	16	26,09%	12	6,52%	3	46	0
Q8. Digital tools are usually user-friendly and work as intended.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
4,35%	2	19,57%	9	47,83%	22	26,09%	12	2,17%	1	46	0
Q9. Tools relying on digital technologies are trustworthy.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
2,17%	1	19,57%	9	28,26%	13	43,48%	20	6,52%	3	46	0
Q10. Seafarers are provided with adequate training to operate digital tools.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped

4,35%	2	28,26%	13	39,13%	18	28,26%	13	0,00%	0	46	0
Q11. Digitalisation of work tools create new risks (cyberthreats, digital equipment malfunctions...).											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
0,00%	0	0,00%	0	8,70%	4	58,70%	27	32,61%	15	46	0
Q12. Digitalisation will lead to a reduction in ship crew size.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
2,27%	1	31,82%	14	36,36%	16	25,00%	11	4,55%	2	44	2
Q13. Increased digitalisation would move more tasks/responsibilities on-shore (e.g. remote operations, engine oversight, etc...)											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
0,00%	0	15,22%	7	26,09%	12	50,00%	23	8,70%	4	46	0
Q14. Digital tools will fundamentally change the work of seafarers in the next 10 years											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
0,00%	0	19,57%	9	6,52%	3	65,22%	30	8,70%	4	46	0
Q15. Overall, an increased use of digital tools on board ships is a positive development.											
Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree		Answered	Skipped
2,17%	1	4,35%	2	10,87%	5	54,35%	25	28,26%	13	46	0