Robotics4EU

Boosting Wider Adoption of Robotics in Europe

D3.2

Knowledge transfer and capacity building in healthcare

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Deliverable 3.2

Knowledge transfer and capacity building in healthcare

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1 Executive Summary

Robotics4EU WP3 “Empowerment of responsible robotics community” aims to broaden and empower the responsible robotics community by transferring knowledge and sharing good practices about non-technological aspects of robotics and their impact.

To further investigate the challenges identified in the project’s Needs Analysis deliverable, covering ethical, legal, socioeconomic, cyber-security, data protection, privacy, diversity, and inclusive engagement issues – the NTNU team organised five thematic workshops for healthcare robotics. Workshops were organised in close collaboration with other robotics research institutions, including the eLaw centre at Leiden University in The Netherlands, the University of Stavanger in Norway, Monash University in Australia, and other robotics stakeholders with access to the healthcare area in robotics.

Four of five workshops are in an online format, with the final workshop being in-person in Trondheim, Norway. Workshops attracted representatives from academia, industry, business, media and the general public. Along with insightful presentations and discussions among speakers, these events successfully served as a platform for networking and establishing connections in the robotics community for the healthcare field.

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2 Introduction

This is a public report on five workshops on the topic of healthcare robotics organised by the Norwegian University of Science and Technology (NTNU) for the project Robotics4EU. The first four workshops were digital and took place on the Zoom platform while the fifth was physical and took place in Trondheim, Norway. The workshops followed the format developed by the Robotics4EU consortium. The workshop first opened with one or two **keynotes** by prominent researchers, developers, innovators and highly qualified professionals who work in the robotics industry, then continued with **brainwriting sessions** including **audience polls** to capture the audiences' attitudes towards robots, with guided **breakout room discussions** centred around five types of challenges the widespread adoption of robots face in society envisaged by the Robotics4EU project. **(1) ethical challenges; (2) legal challenges; (3) challenges related to data protection** and data management; (**4) socio-economic challenges** and **(5) challenges related to education and engagement**. Another round of **audience polls** was then finally used at the end of each event to capture the participants' attitudes, experience, and opinions with robotic systems.

The event participants were based in many different countries, primarily from across the **different regions of Europe,** with international participation from, e.g., the **United Kingdom, United States, China, and other countries.** The audiences consisted of several stakeholder groups such as researchers who work in academia and/or industry, healthcare professionals, healthcare managers, technology developers, end-users, and a variety of students from different disciplines. In **total 252 participants** attended the workshops (exceeding the KPI of 230 participants). As one of the main focuses of Robotics4EU is to develop a "**Maturity Assessment Model**" (MAM) and the project's development of a "**societal readiness score for robots**" the workshops were designed so that the themes and topics discussed would be highly relevant as knowledge produced to feed into these developments of the project and inform them on important concerns, barriers, and opportunities of healthcare robotics. The five challenges listed above were thus chosen to inform the design of the Maturity Assessment Model by exploring the societal readiness of different healthcare robotic systems in the different workshop themes; (1) exploring caring imaginaries, (2) working and living with robots, (3) healthcare robotics in pandemic times, (4) diversity & gender in healthcare robotics, and (5) Health-tech-care in the year 2050 on the future of technologized care.

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3 Approach

3.1 Selection of topics

Workshops were thematically centred based on identified challenges related to the non-technological impact of robotics. The workshops' topics were selected based on several inputs, the main contributor being Deliverable 1.2.

"Robotics community, citizens and policy makers needs analyses" (Deliverable 1.2.). During this analysis, the project team identified 5 main issue areas: socio-economic, ethical, data, legal and education and engagement, as presented in Figure 1. The needs analysis allowed us to choose the most relevant topics to tackle the main issues identified by the stakeholders, participating in the survey. The needs analysis guided also the brainwriting session design and the discussions, by providing in-detail insights on the most relevant topics. Starting with the topics identified, the aim was to spread awareness about these issues in the community, simultaneously, building on the knowledge that will inform the other steps in the project, based on the community feedback and insights.

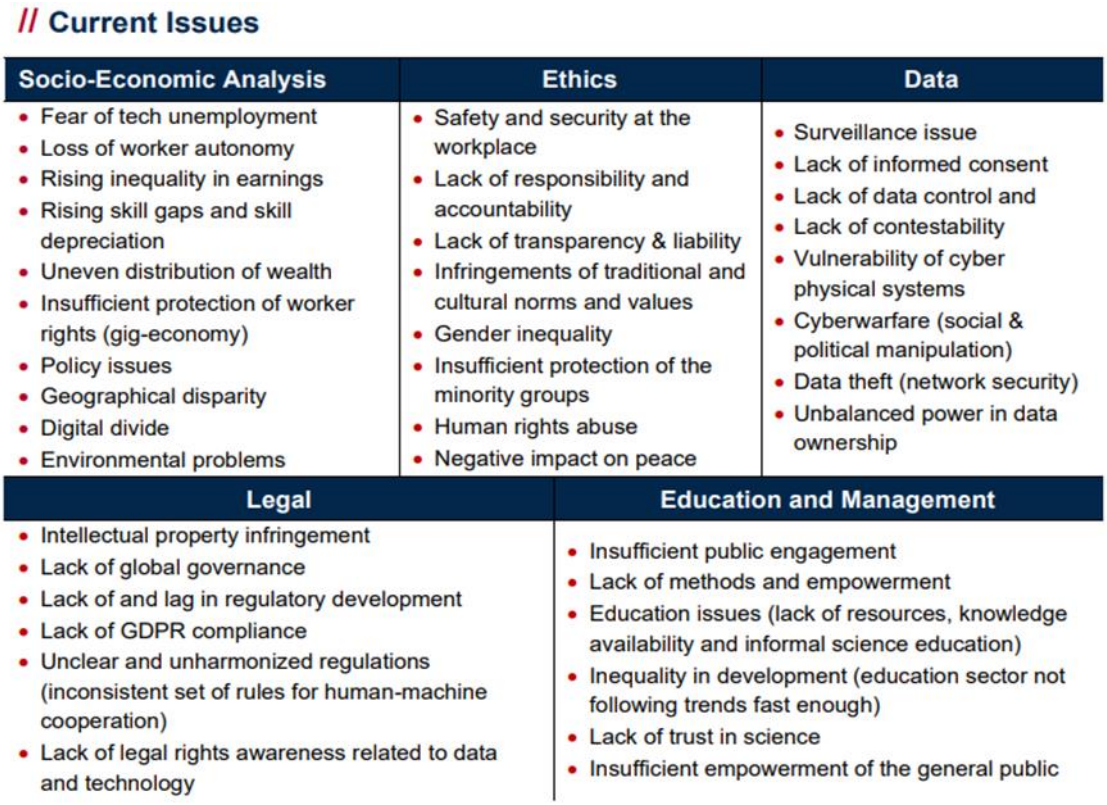

Figure 1 Main issues areas identified in D1.2. "Robotics community, citizens and policy makers needs analyses"

The preliminary topical guidelines and relation to non-technological issues areas were defined in WP3 task "Methodology of the community building and knowledge transfer events. The topics were adapted to match the inputs of the participants to the workshops, identified during the brainwriting sessions and discussions.

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3.2 Workshop format and agenda

The main organiser of the five healthcare robotics focused workshops was NTNU, with other related research projects and organisations as co-organizers. The co-organizers of the workshops were the “Caring Futures project” (workshops 1 and 4), the “LIFEBOTS EXCHANGE EXTENDED project” (workshop 5), the Nordic Journal of Science and Technology Studies (workshop 1), the DigiKULT research group and Monash University (workshop 2) and Good Brother COST action on “Privacy-aware audio- and video-based applications for Active and Assisted Living” (workshop 4) The first four workshops were digital, while the last (workshop 5) took place in Trondheim, Norway. The key outcome for the workshops were to obtain opinions and ideas of various participants and facilitate the discussion of robots in healthcare, to inform the robotics4EU projects further activities, of which transferability we will return to after summarising the workshops.

For all workshops, we followed the chosen Robotics4EU methodology of "Community building and knowledge transfer events "—where participants can communicate with each other, think together, conduct investigation and analysis, discuss together how to promote the plan, and even take practical actions.

All workshops followed a standardised agenda format, with minor adjustments, depending on the topic and speakers. The model of workshops includes three phases – Initiation, Ideation and Discussion. Adaptation of the model for the workshops in this task are presented in Table 1. Detailed agendas of each workshop are presented in Appendix 1.

Phase	Agenda items
Initiation	- Welcome from Project PI or other leads with a presentation of the Robotics4EU Project and of the Maturity Assessment Model - Presentation of the workshop (theme, agenda, speakers)
Ideation	- Presentation from experts - Brainwriting session with polls
Discussion	- Break-out room discussions with summaries - Final poll and conclusions

Table 1 Overall agenda for the workshops – see Appendix 1 for full agendas of the workshops.

The first part, **initiation,** started with a welcome from the project PI or other leads of the project with a presentation of the Robotics4EU Project and of the Maturity Assessment Model. The **ideation** part then continued with presentations from experts which were invited professionals with expert skills that directly contribute to the topic discussed. Each workshop had 1-3 speakers with their presentations lasting from 15 to 25 minutes. Discussion then followed with a brainwriting session aimed to involve the participants in the process of proposing and identifying the most important issues and challenges related to the theme of the workshop. The polls were initiated by the Robotics4EU hosts to capture participants’ experience and thoughts on robots.

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The **discussion** stage involved breakout rooms for various topics, e.g., ethical issues, legal issues, data management issues, socioeconomic issues relevant to the workshop content. These breakout rooms used the application "Padlet." This stage mainly uses group discussions where participants can exchange ideas, stimulate brainpower, and co-create content. Each padlet had several pre-written discussion questions or topics that participants could respond to; participants could also pose their own. In practice the padlets represented half of the interaction; questions and responses to prompt discussion, which was also moderated by a workshop leader who also took notes of the discussion. The padlets themselves can then be exported as PDFs for easier analysis following the workshop.

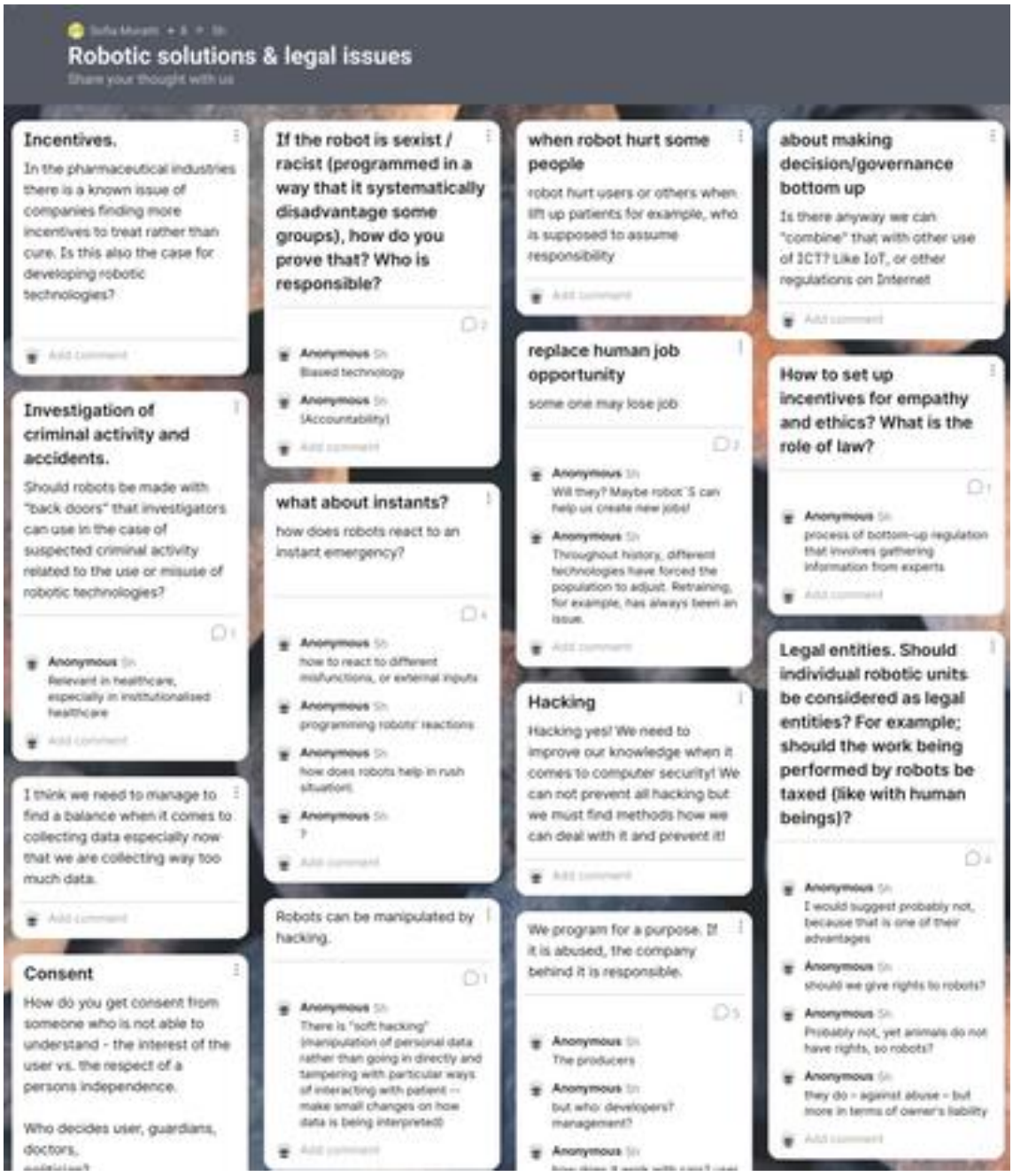

Figure 2 Padlet as user sees it during the workshop, from discussion of legal issues during Workshop #2: Working and living with robots: Future visions and realistic everyday futures

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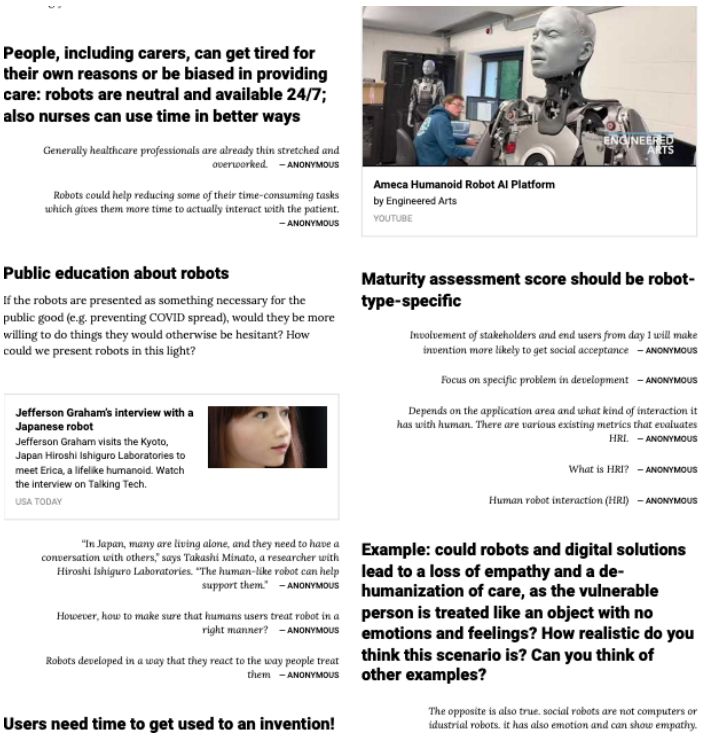

Figure 3 Excerpt from a PDF export of padlet. From a discussion of ethical issues relating to COVID healthcare robots, Workshop #3, Healthcare Tech in Pandemic Times.

There are two reasons for using digital tools such as Padlet in the workshop process: first, to get co-creators to pour out what they already know, and second, to visualise the co-creators' ideas so that all participants in the brainwriting session can discuss the problem together. The final stage of the workshops was the presentation time of each brainwriting group, sharing the results of previous discussions and communicating with other groups.

All workshops were designed to have strong collaborative and interactive elements, with the goal of helping to build a more robust healthcare robotics community. The initial portion of the workshops consisting of introductions to responsible robotics and keynote presentations were collaborative in that the keynotes were focused on practical applications and experience sharing. The subsequent portions were interactive through the active participation of all attendees in discussion and brainwriting sessions. Use of the padlet platform allowed participations to write ideas and make comments in real-time, allowing participants to interact either through speaking or writing.

3.3 Deviations in Methodology

The methodology, created at the beginning of the project, was adjusted to ensure the specifics of the field of healthcare robotics. In specific, the audience was deemed to need some good examples of healthcare robotics before starting the brainwriting and polling, so we decided to put the expert presentations before this, in contrast to some of the workshops from other sectors where robots might be more well-known to the audiences. The workshop attendees would be familiar with robotics in healthcare in general, but the attendance was broad enough that the entire attendance was not often familiar with the specific robots in question.

Additionally, we shortened the duration of the workshops from three hours envisioned in the original methodology to two hours. The first workshop was three hours and followed the planned methodology carefully. However, by the end of the workshop we noticed that many people had left and interactive participation by attendees was much less robust. The two-hour workshop plan maintained the framework of Initiation, Ideation, and Discussion, but the shortened workshops better facilitate for people's busy schedules.

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4 Overview of the Workshops

The following section summarises the five workshops, with tables for quick access of information, followed by a general summary of each workshop.

4.1 Workshop #1 "Exploring care imaginaries: The future of roboticized healthcare"

General information	**Robotics4EU first online healthcare workshop**
Event type	Online workshop
Priority area related to the event	Healthcare
Event theme	**Exploring care imaginaries: The future of roboticized healthcare**
Organising partner	NTNU
Other associated parties	Caring Futures: Developing Care Ethics for Technology-Mediated Care Practices funded by the Norwegian Research Council, led by University of Stavanger. The *Nordic Journal of Science and Technology Studies*, an academic journal.
Date of the event	19.11. 2021
Location of the event	Zoom (online)
Number of participants	49
Description of participant profiles	Scientific community (55%), industry (10%), general public (5%), and non-governmental organisations (20%) and others (10%)
Event abstract	The world's population is ageing – and robots are increasingly portrayed in care roles in fiction. What will the roboticized future of health care look like? In this workshop, we explore how medical and care robots are imagined in fiction, and reflect on the opportunities, inspiration, fear and trouble it can imply for human societies. What boundaries are there for robotic care? Which possibilities exist, or can be opened up in the future? Workshop participants will work together on discussing grand societal issues of the care sector at a time of technological transformation.

Table 2 Robotics 4EU first digital healthcare workshop.

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In the first healthcare workshop is titled **"Exploring Care Imaginaries: The Future of Roboticized Healthcare"** participants explored how medical and care robots are imagined in fiction to reflect on the opportunities, inspiration, fear and trouble it can imply for human societies of today and the near future.

4.1.1 Participants

There were 49 participants who came to our first digital workshop. Among these attendees, a total of 55 percent of them registered as members of the scientific community, and a total of 10 percent came from industry, and 5 percent of participants was from the public, and 20 percent was from non-governmental organisations and 10 percent was from other sectors. Some examples of discussion points from the participants include:

"Can a robot care? And to what extent does a robot care? Humans are very complicated beings, but he does not think robots can be as complicated as human beings."

"Some patients have special bonding, such as special needs to another individual, probably the robot could replace and present as an alternative need, however, it is very difficult to deliver. "

4.1.2 Expert keynote speaker(s)

The keynote in the first workshop, "**Exploring Care Imaginaries: The Future of Roboticized Healthcare"** was Dr. Roger Søraa[1] who is also part of the Robotics4EU project. In his talk titled "*Imaginaries of care robots*", he explored the fictional roots of care robots, and how robots in fiction have a long tradition of helping humans. Dr. Søraa's talk centred around the robot as an "other" and how cinema has long shown the robot as a mirror to what human emotions can be reflected upon. A 2nd keynote was scheduled but had to drop out last minute due to a healthcare emergency, which left no time to find a replacement.

Figure 4 Workshop # 1 Keynote speaker Dr. Roger Søraa

4.1.3 Summary and takeaways of the workshop

The Workshop participants worked together on discussing grand societal issues of the care sector at a time of technological transformation. For this first event, the participant group targeted was broadly defined as people interested in healthcare technology and curious about the new horizons opened by robotics in the care setting. The purpose of this healthcare workshop was to examine how medical and care robots are depicted in fiction and how that reflects the potential opportunities and challenges they present for society in the present and near future. The workshop discussions made it clear that robots in fiction can teach us about using and developing healthcare robots in society today, e.g., how:

[1] Dr. Søraa is an Associate Professor at the Department of Interdisciplinary Studies of Culture (KULT), with a PhD in Studies of Technology and Society (STS). His research focus is on automation, robotization, and digitalization of society – how humans and technology relate to each other. Dr. Søraa is especially interested in the social domestication of technology, see e.g. his research on hospital robots and gerontechnologies of the home. He's also affiliated with Department of Neuromedicine and Movement Science, where he works on the project LIFEBOTS.

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(1) Depictions of robots in fiction can help us imagine the potential uses and capabilities of healthcare robots in the real world. By considering how robots are used in fictional settings, we can get ideas for how healthcare robots could be used in the future, and what kinds of tasks they might be able to perform.

(2) Robots in fiction can also help us think about the potential challenges and ethical concerns that might arise when using healthcare robots. For example, a fictional portrayal of a healthcare robot might raise questions about issues such as consent, privacy, or accountability. By considering these issues in the context of fiction, we can start to develop strategies for addressing them in real-world situations.

(3) Robots in fiction can help us think about the societal and cultural impacts of healthcare robots. For example, a fictional portrayal of a healthcare robot might raise questions about how such technology might change the way we think about caregiving or the role of human healthcare workers. By considering these issues in the context of fiction, we can start to anticipate and address them in the real world.

These aspects are particularly important for assessing Societal Readiness and Maturity Assessment Models, which we return to in part 5 (outcomes and transferability) of the report.

4.2 Workshop #2 “Working and living with robots: Future visions and realistic everyday futures”

General information	**Robotics4EU second online healthcare workshop**
Event type	Online workshop
Priority area related to the event	Healthcare
Event theme	**Working and living with robots: Future visions and realistic everyday futures**
Organising partner	NTNU
Other associated parties	The NTNU *Digitalization and Robotization of Society research group* (DigiKULT) and the research project “AUTOWORK: Workers in transition through automation, digitalization, and robotization of work” funded by the Norwegian Research Council.
Date of the event	18. 01. 2022
Location of the event	Zoom
Number of participants	122
Description of participant profiles	Scientific community (73%), industry (2%), general public

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(with numbers by target group)	(5%), and non-governmental organisations (%) and others (20%)
Event abstract	This workshop focuses on discussing robots used for healthcare. For example, there is a fear that robots will displace workers from their jobs, but robots could also be an asset – relieving workers from doing physically and psychologically strenuous, less desirable tasks. This workshop allows for substantial discussion about what the fears are and what features or safeguards can be put in place to address these fears.

Table 3 Robotics4EU second healthcare digital workshop.

The second workshop titled **"Working and living with robots: Future visions and realistic everyday futures"** discussed robots in healthcare and particularly care robots for assisted living in a healthcare worker context.

4.2.1 Participants

For this workshop, we had many participants, in total 122 people. About 73 percent of attendees represented the scientific community, with only 2 percent from industry, and a total of 5 percent of the general public, and 20 percent of participants came from other sectors. For this workshop 70 percent of respondents were from Norway, because NTNU team decided to collaborate with relevant research departments and groups such as an IoT related group at Oslomet University, located in Oslo, Norway, and its own DigiKULT group due to the common interests on smart home and care robotics. This topic resonated more with groups from the scientific and educational community which is a finding in and of itself.

4.2.2 Expert keynote speaker(s)

The keynote in the second workshop, was Professor Sarah Pink[2]. Her keynote presented the findings from her *Smart Homes for Seniors* project, where she learned about how seniors would live with emerging tech, including robotic vacuum cleaners and voice assistants.

Figure 5 Workshop #2 Keynote speaker Prof. Sarah Pink

4.2.3 Summary and takeaways of the workshop

The workshop participants discussed how there is a fear that robots will displace workers from their jobs, but that robots could also be an asset – relieving workers from doing physically and psychologically strenuous, less desirable tasks. This workshop allowed for substantial discussion about fears and safeguards that can be put in place to address them. This was a popular event with 122 participants, mainly members of the scientific

[2] Sarah Pink is professor of Design and Emerging Technologies at the Faculty of Information Technology, Monash University, Australia. She is also Director of the Emerging Technologies Research Lab, Leader of the Transport Mobilities Focus Area and Co-Leader of the People Programme, at the ARC Centre of Excellence for Automated Decision-Making & Society, and Associate Director of the Monash Energy Institute.

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community (higher education, research); the media; investors; people who work in the industry; civil society and the public were also represented. Most participants (70%) were based in Norway; however, other countries were also represented. The information in the graphs below is based on our registration forms. During the workshop the participants discussed both positive and negative implications for healthcare workers when robots are used in healthcare settings. On the positive side:

(1) Robots can assist healthcare workers by performing tasks that are repetitive, physically demanding, or potentially hazardous. This can free up healthcare workers to focus on tasks that require more human interaction and judgement, such as patient assessment and treatment planning.

(2) Robots can also improve the efficiency of healthcare delivery by automating certain tasks and processes. This can help healthcare workers to see more patients in each day, potentially reducing the workload and increasing job satisfaction.

(3) In some cases, robots may be able to provide care to patients in remote or underserved areas, potentially expanding access to healthcare for people who may not have had it otherwise.

While on the negative sided, it was discussed how:

(1) There is the potential for robots to replace some healthcare jobs, particularly those that are more routine or less complex. This could lead to job losses for some healthcare workers and could also potentially lead to a decline in the overall number of healthcare jobs available.

(2) Some healthcare workers may feel that robots are not capable of providing the same level of care and compassion as a human healthcare worker. This could lead to some resistance to the use of robots in healthcare settings.

(3) There may be concerns about the accuracy and reliability of robots in healthcare, particularly if they are used to make diagnoses or recommend treatments. If there are errors or problems with the use of robots in healthcare, it could potentially harm patients and damage the reputation of the healthcare facility.

4.3 Workshop #3 “Healthcare Tech in Pandemic Times “

General information	**Robotics4EU third online healthcare workshop**
Event type	Online workshop
Priority area related to the event	Healthcare
Event theme	**Healthcare Tech in Pandemic Times**
Organising partner	NTNU
Other associated parties	SDU Robotics & UBTECH Robotics

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Location of the event	Zoom
Date of the event	15.03. 2022
Location of the event	Zoom
Number of participants	26
Description of participant profiles (with numbers by target group)	Scientific community (67%), industry (17%), general public (3%), and non-governmental organisations (6%) and others (7%) *
Event abstract	The pandemics brought along new understandings of healthcare settings organisation and inter personal distancing: that has translated into new spaces and broader roles for robotic technologies. In this workshop, Scandinavian and international experts who work at the interface between top-level robotics research and industry will present concrete healthcare robotic solutions they contributed to develop and introduce under COVID.

Table 4 Robotics4EU third digital healthcare workshop

The third workshop, **"Healthcare Tech in Pandemic Times"** explored how the COVID-19 pandemic that was at the time fully ongoing brought new understandings of healthcare organisation and interpersonal distancing. This has in some ways translated into new spaces and broader roles for robotic technologies.

4.3.1 Participants

For this workshop, 26 people attended, and about 67 percent of attendees represented the scientific community, and 17 percent of them were from industry, with only 3 percent from the public, a total of 6 percent of these attendees was from non-governmental organisations and 7 percent registered as others.

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4.3.2 Expert keynote speaker(s)

Figure 6 Workshop #3 Keynote speaker Prof. Thiusius Savarimuthu

The third workshop had two keynotes: Thiusius R. Savarimuthu[3], SDU Robotics (Odense, Denmark) with a talk titled: " CoVid-19 Swab robot in 5 weeks" and Yang Shen[4], UBTECH Robotics (Pasadena CA, US & Shenzhen, China) with a talk titled "ADIBOT: A UV-C Disinfection Robot System for the COVID-19 Pandemic". They both work at the interface between top-level robotics research and industry and presented concrete robotic healthcare solutions they contributed to develop and introduce under COVID.

Figure 7 Workshop #3 Keynote speaker Dr. Yang Shen

4.3.3 Summary and takeaways of the workshop

The experts presented healthcare robotic solutions made to mitigate issues that emerged from the COVID-19 pandemic, like taking swabs from people's throats. This workshop was a more practical oriented workshop on a concrete case, where the participants gained insight more from industry and applied technological research, rather than academic talks about concepts. The workshop participants discussed why it is important to consider healthcare technology in times of pandemics, such as the COVID-19 pandemic, for several reasons:

(1) Technology can help to reduce the burden on healthcare systems during a pandemic by allowing more patients to receive care remotely. For example, telemedicine technologies can enable patients to receive consultations, diagnoses, and even treatment without having to visit a healthcare facility in person. This can help to reduce the risk of transmission of the disease and free up hospital beds for the most seriously ill patients. On the downside, relying too much on technology that is not properly piloted and tested can have negative consequences (such as faulty components, lack of user acceptance, or discriminatory design), but in times of crises, there might not be enough time to go through usual development processes.

(2) Technology can also help to protect healthcare workers from exposure to the virus by allowing them to interact with patients remotely or through the use of personal protective equipment (PPE), or through healthcare service robots e.g., for taking swabs or for cleaning and disinfection. This can help to reduce the risk of healthcare workers becoming infected and help to ensure that there are enough healthcare workers available to treat patients.

[3] Professor Thiusius Rajeeth Savarimuthu received his B.Sc. degree in Computer System Engineering, his M.Sc. in Computer System Engineering at the University of Southern Denmark in 2007, and his Ph.D. degree in Robotics and Embedded Medical Vision in 2011. He is currently working as a full professor at the Maersk Mc-Kinney Moller Institute at the University of Southern Denmark, where he is heading the Medical Robotics group and is vice section head for the SDU Robotics.

[4] Dr. Yang Shen is currently a research engineer working on multiple healthcare robotic products at UBTECH North America R&D Center (Pasadena, California, USA). With a Ph.D. from University of California Los Angeles (UCLA), Yang's research interests include medical robotics, physical human-robot interaction (pHRI), and general robotics software architecture.

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(3) Technologies such as robots can be used to develop and distribute vaccines and treatments for the disease. These robots might not directly treat patients but are part of a larger robotic network of healthcare logistics, e.g., delivering vaccines by drones, or manufacturing vaccines, showing the overlap of healthcare robotics into other fields. For example, the COVID-19 vaccines are developed and are being produced using a variety of technological innovations, also robotics.

(4) Technology can also help to track and monitor the spread of the disease, allowing public health officials to respond more effectively to outbreaks and implement measures to control the spread of the virus. In some cases, robots are also used to monitor and control citizens, of which ethical consequences should be under scrutiny and ethical assessment as well.

4.4 Workshop #4 “Diversity & gender in healthcare robotics”

General information	**Robotics4EU fourth online healthcare workshop**
Event type	Online workshop
Priority area related to the event	Healthcare
Event theme	**Diversity & gender in healthcare robotics**
Organising partner	NTNU
Other associated parties	Caring Futures: Developing Care Ethics for Technology-Mediated Care Practices and the Good Brother COST action on “Privacy-aware audio- and video-based applications for Active and Assisted Living”.
Date of the event	27.04.2022
Location of the event	Zoom
Number of participants	31
Description of participant profiles (with numbers by target group)	Scientific community (45%), industry (9%), general public (6%), and non-governmental organisations (9%) and others (31%)
Event abstract	Robots are becoming an important part of many sectors of society. In healthcare, robots perform many different tasks. Which groups of people are impacted by these robots, and in what ways—is any social groups excluded, and can robots have bias? In this workshop we will take a deeper dive into diversity and gender aspects of healthcare robotics, with keynote experts from the field, discussions, and frameworks from the Robotics4EU project.

Table 5 Robotics4EU fourth digital healthcare workshop

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The fourth workshop, **"Diversity & gender in healthcare robotics,"** focused on how groups of people are impacted by robots and one the inclusion and exclusion of particular groups in robotics design. It was co-organized with the “Caring Futures: Developing Care Ethics for Technology-Mediated Care Practices” project and the Good Brother COST action on “Privacy-aware audio- and video-based applications for Active and Assisted Living” project.

4.4.1 Participants

In this workshop, 31 participants were there, with a total of 45 percent of the participants registered as scientific community, and another 9 percent was from industry, and 6 percent of attendees was from the general public, and a total 9 percent of them represented non-governmental organisations and 32 percent of these attendees was from other sectors.

4.4.2 Expert keynote speaker(s)

This workshop had two keynotes. The first was titled: “The consequences of missing diversity considerations in healthcare robotics,” presented by Eduard Fosch-Villaronga, Assistant Professor at the eLaw Center for Law and Digital Technologies at Leiden University (NL). The second keynote: “Gender, care and robots” was held by Ingvil Førland Hellstrand, Associate Professor of Gender Studies at the University of Stavanger

Figure 8 Workshop #4 Keynote speaker Assis Prof. Eduard Fosch-Villaronga

Figure 9 Workshop #4 Keynote speaker Assoc Prof. Ingvil Førland Hellstrand

4.4.3 Summary and takeaways of the workshop

Participants discussed why it is important to consider diversity and gender aspects when it comes to healthcare robotics for several reasons:

(1) Diversity and gender considerations can help to ensure that healthcare robotics are developed and used in a way that is fair and equitable for all members of society. If certain groups are excluded or disadvantaged by the development and use of healthcare robotics, it could e.g., lead to social and economic inequalities.

(2) Diversity and gender considerations can also help to ensure that healthcare robotics meet the needs and preferences of a wide range of users. For example, healthcare robotics that are designed with a specific gender in mind may not be suitable for use by people with a different gender, or by those who do not identify with a specific gender.

(3) Diversity and gender considerations can help to promote the acceptance and adoption of healthcare robotics by a wider range of users. If individuals feel that healthcare robotics are not designed with their needs and preferences in mind, they may be less likely to use them.

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Overall, considering diversity and gender aspects when it comes to healthcare robotics is important to promote the development and use of these technologies in a way that is inclusive, fair, and responsive to the needs of all members of society.

This ties into the overall Robotics4EU strategy on raising awareness on gender and diversity of robotic systems. There are several ways in which the robotic community can benefit from a more responsible, ethical, and inclusive approach to robots. By considering the ethical and social implications of robots, the robotic community can help to ensure that these technologies are developed and used in a way that is fair and beneficial to all members of society. This can help to promote the acceptance and adoption of robots by a wider range of users and can also help to prevent unintended negative consequences of their use.

As discussed by the workshop participants, a more responsible and inclusive approach to robots can help to ensure that these technologies are designed and developed with the needs and preferences of a diverse range of users in mind. This can help to make robots more accessible and useful for a wider range of people and can help to promote their adoption and use. By taking a more ethical and responsible approach to robots, the robotic community can help to build trust and confidence in these technologies among the public. This can help to foster a more positive view of robots and their potential to improve our lives and can help to promote their development and use in a way that is beneficial for society, informing the Robotics4EU project on Societal Readiness (part 4).

4.5 Workshop #5 “Health-tech-care in the year 2050: Workshop on the future of technologized care”

General information	Robotics4EU fifth healthcare workshop
Event type	Physical workshop
Priority area related to the event	Healthcare
Event theme	**Health-tech-care in the year 2050: Workshop on the future of technologized care**
Organising partner	NTNU
Other associated parties	LIFEBOTS-Exchange Extended (LEE), a Norwegian Research Council funded project no. 09420
Date of the event	24.05.2022
Location of the event	Scandic Lerkendal hotel, Trondheim, Norway
Number of participants	24
Description of participant profiles	Scientific community (66%), industry (10%), general public

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(with numbers by target group)	(16%), and non-governmental organisations (2%) and others (6%)
Event abstract	What possible trajectories are there for the robotization of healthcare in the next 30 years? What robots are currently used in healthcare, and how will they change? We will hear from digitalization experts and practitioners in digitalized and robotized healthcare to hear what they think the landscape will look like in 2050.

Table 6 Robotics4EU physical healthcare workshop.

The fifth and last workshop took place physically in Trondheim, Norway. The title was **"Health-tech-care in the year 2050: Workshop on the future of technologized care".** The workshop explored the possible trajectories for the robotization of healthcare in the next 30 years, what robots are currently used in healthcare, and how they will change.

4.5.1 Participants

For our first physical healthcare workshop, in total there were 24 participants, a total of 66 percent of registered attendees represented the scientific community, and 10 percent was from industry, and 16 percent of participants registered as general public, and only 2 percent was from non-governmental organisations and 6 percent registered at other sectors.

4.5.2 Expert keynote speaker(s)

The fifth workshop had three keynotes. Viviann Maridal, Unit leader at Eidet care centre, member of Ålesund municipality welfare technology team, and Cecilie Campbell, Arena for learning of welfare technology, discussed "Healthcare technology in practice: Lessons learned from the municipal level". Eirik Norman Hansen, Digitalization expert and public speaker, gave a talk entitled "Exponential development and hyper adoption: The future is fantastic." The keynotes were followed by group discussions on three tables thematizing different aspects of the future of healthcare.

Figure 10 Organisers and speakers of the 5th workshop

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4.5.3 Summary and takeaways of the workshop

The workshop was based on insight from the four previous workshops, and the overall robotics4EU project. We invited digitalization experts and practitioners in digitalized and robotized healthcare to hear how they think the landscape will look in 2050. The event was hosted by: Robotics4EU NTNU, IMRO-Lab, LIFEBOTS, LEE, AUTOWORK with participants from the scientific community, the industry, civil society, the general public, and the media. As this workshop was both longer and more elaborate than the previous ones, many insights and discussion points arose:

(1) One potential insight is a better understanding of the likely direction and trajectory of healthcare technology in the coming decades. By discussing and brainstorming about the future of technologized care in 2050, participants could get a sense of the kinds of technologies that are likely to emerge and how they might be used in the healthcare setting.

(2) Another potential insight is a better understanding of the potential challenges and opportunities that healthcare technology could present in the future. For example, participants could consider how healthcare technology might change the way we think about caregiving, the role of human healthcare workers, or the availability of healthcare services.

(3) Additionally, by discussing the future of technologized care, participants could get a sense of the societal and cultural impacts of healthcare technology. For example, they might consider how healthcare technology might change the way we think about health, illness, and ageing, or how it might affect issues such as equity and access to care.

Overall, by discussing the future of technologized care, participants could better understand the likely direction and impact of healthcare technology in the coming decades and could start to consider the potential challenges and opportunities that it might present. This ties into all topics that were explored in the previous four healthcare robotics workshops of the project—such as how care imaginaries, worker automation, gendered implications, and pandemic considerations come into play. In the following section, we explain how the key outcomes of the workshops lead to transferable results for the Robotics4EU project, and the impact this can have on the robotics community.

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5 key takeaways and transferable results

The five workshops explored the thematic dimensions, experts', and participants' views on the societal aspects in the field of robotics in healthcare. Following the main goals, identified in the introduction, this section aims to present and summarise how the content presented in the workshops and insights gathered will inform the further activities of the Robotics4EU project, particularly the Maturity Assessment Model (MAM).

5.1 Impact Assessment Outcomes

At the beginning of the workshops, participants were asked to evaluate different statements and whether they: *fully disagree – disagree – I don't know – agree – fully agree* by polls that were launched. Regrettably, due to some software and human error with the Zoom-platform, a few of these poll results have been lost. Below we present summaries of key results, using workshops 3 and 4 as examples:

- **Statement #1: I interact with robots in my work environment.**
  The answer from the participants was quite diverse. For instance, 43 percent of the respondents fully agreed during the third workshop, 29 percent agreed, and 21 percent disagreed.
- **Statement #2: I interact with robots in my home/personal environment.**
  The answers from the participants were quite diverse. During the third workshop, 43 percent of the participants agreed, only 7 percent fully disagreed.
- **Statement #3: I believe I am aware of the issues that the robotic industry faces.**
  During the third workshop, 71 percent of the respondents agreed. After the workshop, 86 percent agreed, with a 15 percent increase.
- **Statement #4: I believe that various aspects of robotics are discussed sufficiently in the public discourse.**
  57 percent of the respondents disagreed, and 36 percent agreed during the third workshop's initial feedback. However, 71 percent agreed with a double increase in the final survey.
- **Statement #5: Technological progress is more important than social progress.**
  50 percent of the respondents disagreed with this question; however, 21 percent of the respondents chose to agree. And in the final survey, 43 percent agreed, with 22 percent of the increase.
- **Statement #6: This work helped me improve my understanding of the issues robotics faces.**
  The last question from the final poll of the third workshop shows that 43 percent of the participants think this workshop has significantly improve their understanding of the issues robotics faces.

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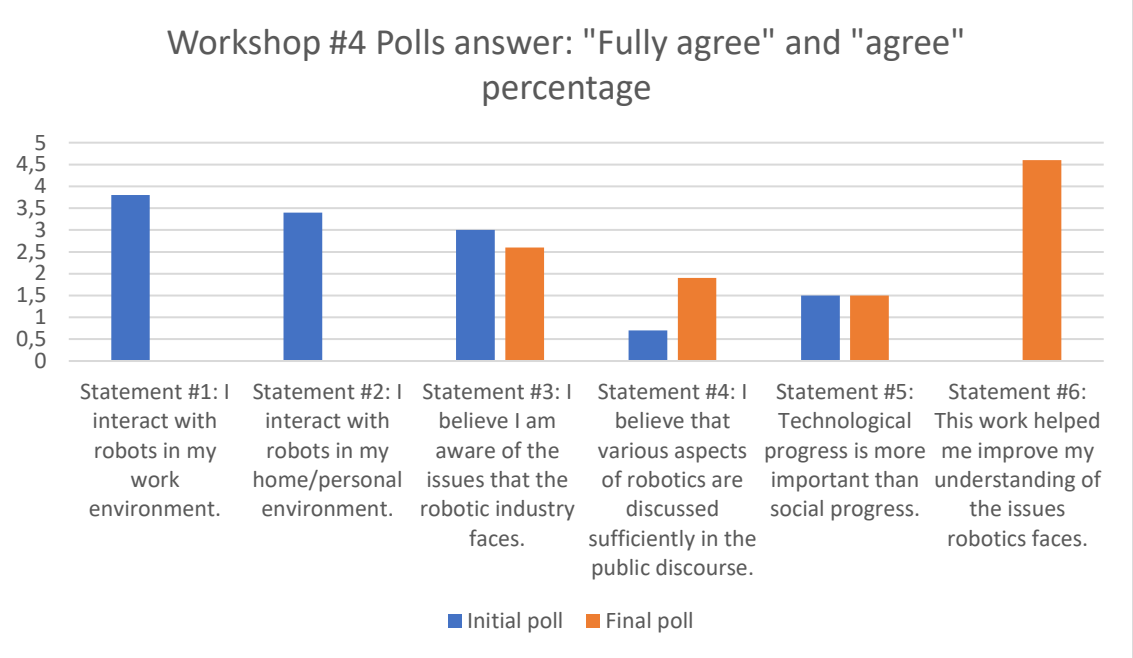

From the Workshop #4 Polls: "Fully agree" and "agree" shows that before this workshop, the participants have a good fundamental knowledge of interacting with robots in both work and home environment. However, after the workshop, their understanding of aware of the issues that the robotic industry faces have changed, and about doubled in the number of participants believe that various aspects of robotics are discussed sufficiently in the public discourse. And about the same number of participants think that technological progress is more important than social progress, but almost everything agree that after the workshop it has helped them improve their understanding of the issues robotics faces. The results from all polls will be transferred as knowledge into the MAM and future project knowledge building.

5.2 Brainwriting and discussion sessions outcomes

The five workshops explored different opportunities and barriers of healthcare robotics, with the aim to feed insight into the rest of the Robotics4EU project, particularly the Maturity Assessment Model and the wider Societal Readiness parts of the project. Below is a table summarising the findings from the workshops, organised thematically. Legal issues and data protection issues were merged after the second workshop, as the discussions tended to partly overlap. Following the table, we discuss the four main themes as outcomes of the workshop:

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Ethics	Law & data protection	Socio-economic	Education & engagement
- Control, "instant emergency" - Hacking - Empathy - Demographics of creators & script	- Accountability: - Discrimination by robots - Discrimination against robots - Taxation - Rights - Top-down incentives to good citizenship - Consent	- Replacement - Loss of autonomy - Rise of inequality - Hard labour - Skills depreciation - Interactions - Division of labour - Robots as luxury	- Depiction in fiction - Technical expertise - Curriculum - Robots as educators - Construction of normality

Table 7 Themes discussed at brainwriting sessions

5.2.1 Ethical Issues

During the discussion on ethical issues related to robotics, several key themes were identified. One of these themes was the issue of control over robots and the effective ways in which to prevent or mitigate sudden and harmful behaviour by robots towards people. Another theme that was discussed was the issue of hacking, or the potential for robots to be controlled by individuals with malicious intentions. Another theme that emerged was the issue of empathy, or the fact that robots, particularly when used in care roles, may not be capable of the same level of psychological intimacy that is expected from human caregivers. Finally, there was a discussion on the relationship between the demographics of the creators of robots and the design of the products, which bears some resemblance to current debates about the demographics of governments and company boards and their potential impact on decision-making and understanding of social issues.

5.2.2 Law and data protection issues

During the discussion on the law and data protection in relation to robotics, several key issues were identified. One of these issues pertained to accountability for discrimination, including both instances of discrimination by robots against certain groups of people and instances of discrimination against highly advanced AI-based robots that possess quasi-human emotions. Another issue that was discussed was the idea of subjecting robots to taxation for their work and granting them rights, as well as the various questions related to privacy and consent that arise in daily interactions with robots that possess data-gathering capabilities that far exceed those of humans. Another notable theme that emerged in the discussion was the potential for implementing top-down measures to incentivize the production and distribution of socially acceptable robots over those with potentially harmful behaviours.

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5.2.3 Socioeconomic issues

During the discussion on socio-economic issues related to robotics, the main theme that emerged was the impact of robots on work and the labour market. Concerns were raised about the potential for robots to replace human workers, leading to skills becoming obsolete or devalued, and contributing to rising inequality. Other issues that were discussed included the loss of autonomy for workers as robots take on more tasks, the complexity of interacting with robot colleagues that may not behave in an acceptable manner, and the potential for new divisions of labour to emerge in the job market as robots enter it, including the possibility of unpaid labour such as care tasks. Another important issue that was raised was the persistence of a traditional view of robot work as akin to "quasi-slave" labour, meaning that robots are mainly used for hard labour that people are unwilling to do, which would make them non-citizens and not eligible for the same rights and protections as human citizens.

5.2.4 Education and engagement issues

During the discussion on education and engagement related to robotics, the focus was on how fiction portrays robots and their behaviour, and how this depiction might influence our understanding of what is seen as normal and acceptable behaviour for robots. Another topic that was discussed was the role that technical expertise should play in education in the future, particularly in terms of understanding the capabilities and limitations of robot-citizens. Additionally, there was a discussion about how robots should be portrayed in school curricula and the importance of considering these issues to better understand and interact with these new technological citizens.

5.3 Inputs for Maturity Assessment Model

One of the essential parts of the workshop's introduction was the Maturity Assessment Model (MAM) presentation. The discussions and brainwriting aimed to provide insight to topics that the MAM explore. At the beginning of the workshops, the MAM was presented by project partners. After 2 organised workshops, the partner leading the MAM development (LNE) made a pre-recorded video which was shown during the workshops and was accessible to the participants after the workshop (and was also used then in other thematic workshops of Robotics4EU for efficiency reasons). The presentation of the model was serving these goals:

- Building the awareness in the community on the development of the model so that it already has some recognition by the time it is introduced.
- Providing context for the importance of the participants' engagement for the design of the model, making sure that wider communities of stakeholders were enrolled in the discussion of the topics feeding into the MAM. One of the aims to structure the workshops in the collaborative approach was to ensure that the community and stakeholders could provide their ideas and insights that could serve as the inputs for the MAM.

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The inputs for maturity assessment model, gathered from the workshops are three-fold:

1. Insights, coming from the topic presentations by experts, discussions in the workshops. These content-related insights build a solid base and provide specific insights into the field of healthcare robotics that serve as a context information for the maturity assessment model delivery.
2. Brainwriting sessions, discussions, and polls, identifying the most relevant issues in the predefined issue areas.
3. Direct discussion with participants and experts in the workshops provided feedback on the MAM's thematic areas, its idea and design. The following section will summarise the main take-aways from these engagements for the workshops organised for inspection and maintenance.

During the discussions, key takeaways for the MAM, in addition to the 5.1 topics discussed were:

- The MAM might have quite a different impact and design in healthcare, compared to more classic robotics areas such as industry (e.g., it should be "domain specific."
- The MAM must balance between heavy ethical and responsibility concerns in healthcare, e.g., compared to other areas where vulnerable humans such as patients might not be as crucial for societal readiness.

Societal readiness for healthcare moves slow compared to many other sectors, but a MAM that works well for healthcare, could be very robust for other sectors with less demands on responsibility to society.

5.4 Community building

One of the difficulties in organising workshops to broaden and empower the responsible robotics community in healthcare robotics was to identify the relevant people - both in search of the right experts for the topics identified and while attracting participants to the workshops. To strengthen and empower the EU robotics community in the healthcare field, workshop organisers made sure to include a wide range of stakeholders who might have an interest in healthcare and robotics. The workshops allowed experts from the robotics projects to engage in the workshops together with researchers, industry, and technical communities, as well as students, healthcare personnel, and laypeople – as healthcare robotics is still quite novel, and not widely adopted in society. Thus, we also wanted to involve potential future users. The engagement strategy has included a wide range of organisations. The list of organisations and our engagement activities is presented in the table below:

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COMMUNITY STAKEHOLDERS	ENGAGEMENT ACTIVITIES
"Caring Futures: Developing Care Ethics for Technology-Mediated Care" research project funded by the Norwegian Research Council	• Co-organizers of two workshops, with WP lead Associate Professor Ingvil Hellstrand as keynote. Robotics4EU presented and discussed with the Caring Futures project, which builds knowledge on ethical implications on societal issues for healthcare robotics.
Nordic Journal of Science and Technology Studies	• Editors of the journal present at workshops, with discussions of journal paper contribution in the future.
AUTOWORK: Workers in transition through automation, digitalization, and robotization of work	• WP leaders of the project present at several of the workshops, e.g. keynotes by Professor Sarah Pink and Associate Professor Roger A. Søraa, on healthcare robotics seen from the project from Australian and Norwegian perspectives.
SDU Robotics	• Professor Thiusius Rajeeth Savarimuthu presented the company's focus on Covid-19 swab robots
UBTECH Robotics	• Dr. Yang Shen presented engineering perspectives from the company's multiple healthcare robotic products.
Good Brother COST action on "Privacy-aware audio- and video-based applications for Active and Assisted Living".	• Associate Professor Eduard Fosch-Villaronga presented the project's focus on privacy and assisted living.
LIFEBOTS-Exchange and LIFEBOTS-Exchange Extended (LEE),	• The EU project LIFEBOTS, as well as the extension project LEE funded by the Norwegian Research Council participated with keynotes in WP5, as well as insight from multiple of the projects' participants throughout the workshops, also by disseminating to their networks and inviting participants.

Table 8 Community stakeholders

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5.4.1 Additional impact & dissemination

- This report is shared on the robotics4eu project website
- The recordings of the expert's presentations during the workshops are uploaded to the Robotics4EU YouTube channel, as seen below. These recordings will be shared on the AI4Demand platform
- The workshops also feed into the Robotics4EU D4.4. Responsible robotics advocacy report, with key insights from healthcare robotics as described in this report's key takeaways and transferable results.
- Finally, the workshops had good impact on raising the awareness of healthcare robotics, both through the wide array of stakeholders and citizens engaged, but also the ripple effects this will have for the projects, companies and organizations that were invited as co-organizers, keynotes, and participants. This long-term effect is difficult to measure, but we received good feedback from many of the abovementioned groups on the merits of such a series of workshops.

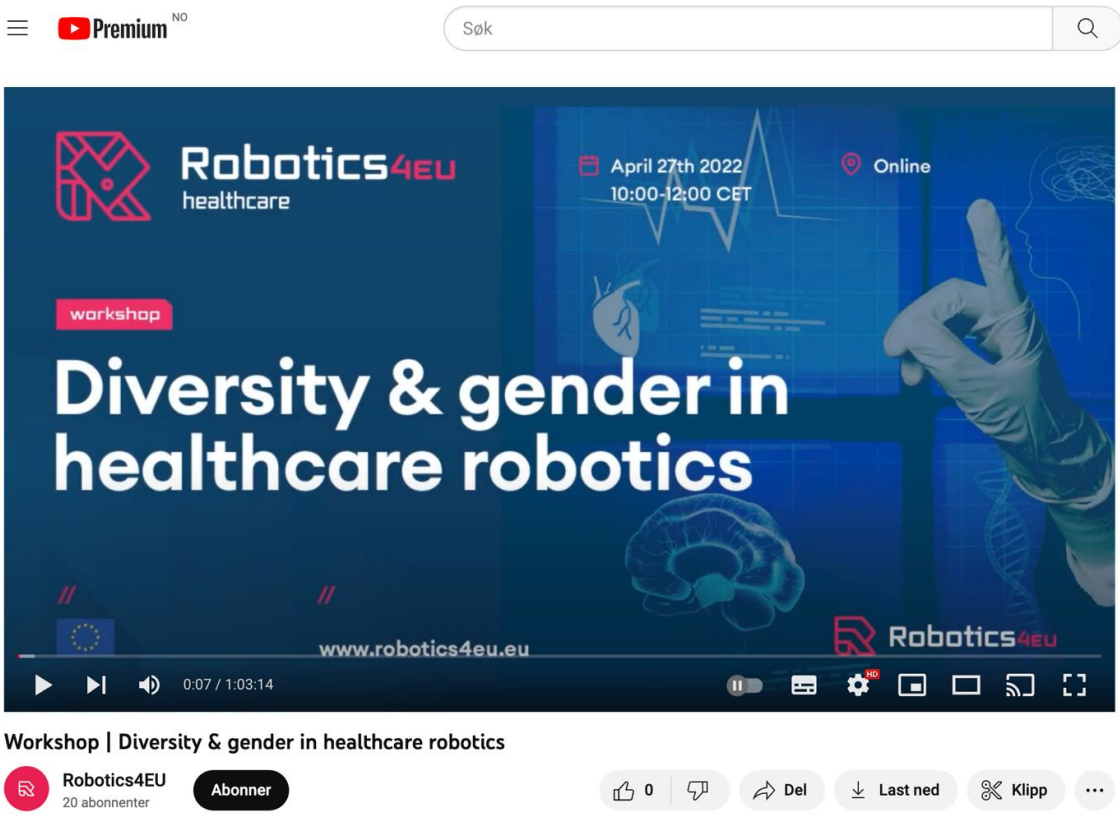

Table 9 YouTube example of workshop recording

6 Conclusions

NTNU successfully organised five workshops on the topic of healthcare robotics, with a total of 252 participants from a variety of backgrounds and countries (exceeding the KPI of 230 participants). The workshops provided a forum for participants to discuss the future of technologized care and consider the potential challenges and opportunities it may present. The key outcomes of the workshops have resulted in transferable results for the Robotics4EU project, especially for the ongoing work on the Maturity Assessment Model and have had an impact on the robotics community. Overall, the workshops were a success in bringing together a diverse group of stakeholders to explore the opportunities and barriers of healthcare robotics. The main discussed topics of the workshops were:

- **Ethical considerations** were a prominent topic of discussion during the workshops, as participants delved into the implications of granting autonomy to robots and the potential for unintended consequences. Discussions centred on issues of control over robotic systems, and strategies for preventing or mitigating harmful behaviour by robots towards humans. Additionally, the potential for hacking and malicious control by individuals was considered, as well as the limitations of robots in providing the same level of psychological intimacy as human caregivers. There were also discussions on decision-making and the understanding of social issues by those who have the power to create robots.
- The **legal and data protection** challenges associated with healthcare robotics were a prominent topic of discussion during the workshops. Discourse centred on the accountability for discrimination in the application of robotics in healthcare, as well as the potential for taxation and granting rights to robots. Additionally, the implications of privacy and consent in regard to data collection by robots were also examined, highlighting the need for further exploration and development of regulations in these areas.
- **Socioeconomic implications** were a prevalent topic of discussion throughout the workshops, with a particular focus on the potential effects of robotics on the labour market. Discussions centred on the potential for robots to replace human workers, resulting in issues such as skill obsolescence and rising inequality. Additionally, the potential loss of autonomy for workers as robots take on more tasks, and the emergence of new divisions of labour within the job market as a result of increased robotics adoption, were also discussed.
- During the workshops, issues related to **education and engagement** were thoroughly examined, specifically the representation of robots in fiction and its potential impact on societal perceptions of acceptable behaviour for robots. Furthermore, the need for technical expertise in education and the appropriate depiction of robots in school curricula were also discussed and generated lively debates among participants.

One of the key insights gained through engagement with the healthcare robotics community **was the relative lack of familiarity with the technology** among laypersons, students, and healthcare professionals. This was attributed to a variety of factors, including cost and technical limitations, as well as societal readiness issues such as trust, acceptance, and legal considerations. These challenges to widespread adoption were acknowledged, but it was also noted that there was a **strong interest among stakeholders in learning more about the technology** and addressing barriers to its adoption. The concept of "warm human caring

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hands versus cold robotic hands" was often cited as a representation of the societal perception of the value of care and the role of technology in providing it. It is clear that many people in society want to learn more about robots, because even if they might not be too familiar with technology like healthcare robotics for the time being, they see the importance it can bring for their futures.

Key outcomes of bringing together a diverse group of stakeholders to explore the opportunities and barriers of healthcare robotics, with people from various backgrounds and countries, was to ensure a wide range of perspectives and expertise represented in the discussions. The focus on five key challenges, such as ethical, legal, education and socio-economic issues, provided a comprehensive understanding of the potential challenges and opportunities that the widespread adoption of robots in healthcare may present. The workshops provided a forum for participants to discuss the future of technologized care and consider the potential challenges and opportunities it may present. These takeaways will help inform the Robotics4EU Maturity Assessment Model from a very ethically and vulnerable sectors that healthcare represents.

It was important to include expert presentations on healthcare robotics for the workshops because they provided valuable insights on the current state and future potential of healthcare robotics and its impact on society. The presentations from research, municipality and healthcare staff, and industry provided a comprehensive understanding and knowledge transfer between academia, industry and the public. This helped to bridge the gap between research and practices and ensure that new technologies and developments are being applied in the real world to meet society's needs.

Audience engagement and discussions were important to further add to the Maturity Assessment Model from a healthcare robotics perspective because they allowed for a diverse range of perspectives and expertise to be represented in the discussions. The participation of 252 individuals from various backgrounds and countries ensured that a wide range of perspectives were represented in the discussions. The discussions helped to identify and understand the resistances and fears that impede a more widespread adoption of healthcare robotics in society and provided insights into the societal readiness and acceptance of healthcare robotics.

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7 Appendix

7.1 Online Workshop 1: Exploring care imaginaries: The future of roboticized healthcare

November 19, 2021 9:30–12:30 CET	
9:30	Welcome and intro by Sofia Moratti, NTNU
9:35	Keynote by Roger A. Søraa, NTNU
10:15	Brainwriting
10:30	Coffee break
10:45	Ideation: debate and experience-sharing. Key questions: Can a robot care? Should a robot care? How are fictional robots caring differently?
11:45	Coffee break
12:00	Discussion: pathways for caring imaginaries
12:30	Close of workshop

Table 10 Agenda of 1st online workshop

7.2 Online Workshop 2: Working and living with robots: Future visions and realistic everyday futures

January 18, 2022 10:00–12:00 CET	
10:00	Welcome and intro by Sofia Moratti, NTNU and Anneli Roose, Civitta
10:15	Keynote by Sarah Pink, Monash University and AUTOWORK
10:45	Break
11:00	Breakout groups and brainwriting
11:30	Plenary discussion
12:00	Close of workshop

Table 11 Agenda of 2nd online workshop

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7.3 Online Workshop 3: Healthcare tech in pandemic times

March 15, 2022 10:00–12:00 CET	
10:00	Welcome and intro by Sofia Moratti, NTNU and Anneli Roose, Civitta
10:20	Keynote by Thiusius R. Savarimuthu, SDU Robotics
10:45	Keynote by Yang Shen, UBTECH Robotics
11:00	Break
11:15	Introduction of the Maturity Assessment Model by Sofia Moratti, NTNU
11:20	Breakout groups and brainwriting
11:50	Plenary discussion
12:00	Close of workshop

Table 12 Agenda of 3rd online workshop

7.4 Online Workshop 4: Gender & diversity in healthcare robotics

April 27, 2022 10:00–12:00 CET	
10:00	Welcome and intro by Sofia Moratti, NTNU and Anneli Roose, Civitta
10:20	Keynote by Eduard Fosch-Villaronga, eLaw Center for Law and Digital Technologies, Leiden University and Good Brother COST action
10:40	Keynote by Ingvil Føland Hellstrand, University of Stavanger and Caring Futures
11:00	Break
11:15	Breakout groups and brainwriting
11:50	Plenary discussion
12:00	Close of workshop

Table 13 Agenda of 4th online workshop

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7.5 Physical Workshop: Health-tech-care in the year 2050

May 24, 2022 10:00–16:00 CET	
10:00	Welcome and intro by Sofia Moratti, NTNU
10:15	Keynote: “Healthcare technology in practice: Lessons from the municipal level” by Vivian Maridal, Ålesund municipality and Cecilie Campbell, Arena for læring om velferdsteknolgi
10:45	Keynote: “Exponential development and hyper adoption: The future is fantastic” by Eirik Norman Hansen, a Digitalization expert
11:30	Lunch
12:30	Future trajectories for healthcare: Scenario presentation from experts • Erland Kleiden-Jorgensen, PA consulting • Kristil Håland, Jodacare
13:45	Coffee break
14:00	Future scenario workshop in small groups
15:30	Final plenary
16:00	Close of workshop

Table 14 Agenda of physical workshop

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