

# DARKO

## *Citizen Survey Results*

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## Introduction

This report presents the results of a collaboration between the project DARKO and the EU-funded project Robotics4EU under grant agreement No 101017283. The collaboration is part of a European wide citizen consultation on validating different robotics business ideas from a societal perspective. In total 11 robotics applications participated in the activity and took part in exploring how citizens can be engaged and give input to the development of new robotic applications.

The assessment of each of the 11 robotic solutions was performed in an online, informed survey style consultation. Here respondents were guided through the survey via an online platform providing them with informative text, pictures or video material and questions about the specific robotic solution. The platform then collected the answers from each of the individual respondents which were further analysed by the Robotics4EU project.

### What is the Robotics4EU project?

The citizen consultation presented in this report is part of Robotics4EU, a 3-year project funded under the European Union's Horizon 2020 research and innovation program. The project aims to ensure a more widespread adoption of robots within the areas of healthcare, inspection and maintenance of infrastructure, agri-food, and agile production. To achieve this, the project is advocating for implementation of responsible robotics principles and raising awareness about non-technological aspects of robotics by organising community building and co-creation events bringing together the robotics community and citizens.

### Why involve citizens' perspectives in the development of robots?

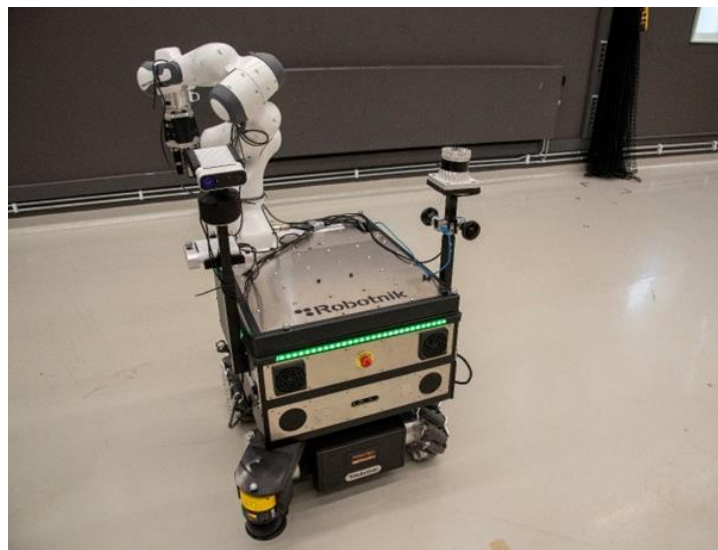
The collaboration between robotics developers and citizens rests on the core democratic notion that technology with the potential to have a significant impact on how we shape our future society, should not only be discussed by stakeholders, policy makers, experts, or businesses, it should also include opinions of the broader public who most likely will be directly or indirectly impacted by the changes the technology may impose over time.

There are several ways in which robot manufacturers can benefit from engaging citizens in their development processes. While citizens may not possess the technical knowledge required to build a robot, they are experts of the social worlds that new technologies will inhabit, change, or at the very least affect in some way or another. This type of expertise is equally important as professional expertise because it is what ultimately decides whether or not society will accept a new technology. Inviting citizens 'behind the stage' can help make sure that the manufacturers' solutions are aligned with society's expectations and needs. The citizens bring an 'outsider' perspective that can be an effective tool to detect and identify concerns and potential problems that would perhaps otherwise emerge only when the robot is fully developed and on the market. Thus, by adopting inclusive approaches from early in the development process, robot manufacturers will be better equipped to make informed decisions about their products and avoid costly mistakes that may ultimately render their solutions(s) unfit for society.

## Presentation

DARKO is a European research project that develops new methods for robots that should work efficiently together with people, particularly in logistics and production.

The central theme for the DARKO robot is efficiency. The robot should navigate efficiently around people – comfortably driving among them in a way that doesn't disturb its co-workers, while still reaching its goals on time. This includes being able to efficiently communicate its intents to the people around it, as well as recognizing their intents.



The robot should be efficient at handling objects – which also includes throwing an object into the target tray, rather than driving there to drop the object. Throwing will save both time and energy. The robot should also be easy for anyone to install at a new site – increasing efficiency by reducing the work effort and modifications that might otherwise be needed to adapt the environment for the robot.

## Demographics

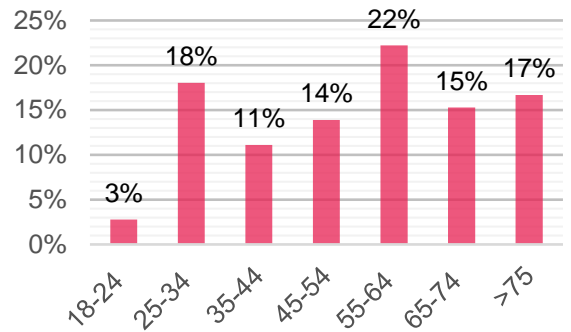
72 respondents answered the online consultation. The highest representation of citizens was the age group 55-64, accounting for 22%. While the distribution of the other age groups was divided closer to each other. The younger generations from 18-24 years were not as well represented.

The gender distribution of citizens was leaning towards a little larger representation of male respondents, with male participants accounting for 57% and female participants accounting for 40%. The remaining either answered 'other' or did not specify their gender.

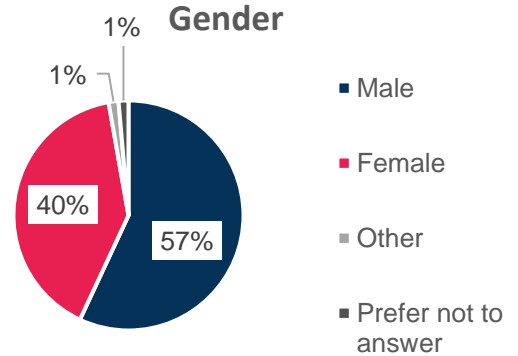
Looking at distribution of areas of residence, a total of 46% of the respondents answered that they lived in a large city. The second most chosen option was small town with a total of 24%, these were followed by suburban with 21% and rural with 8%. The remaining 1% entered 'other' as their area of residence. These results reflect the expectations when taking the distribution of the age groups into account.

The educational level of the respondents was high with 39% having a master's degree, a quarter of the respondents having finished a bachelor's degree, and 24% had a vocational education or training. Every tenth of the respondents had a doctoral degree. The last 3% had a general upper secondary degree.

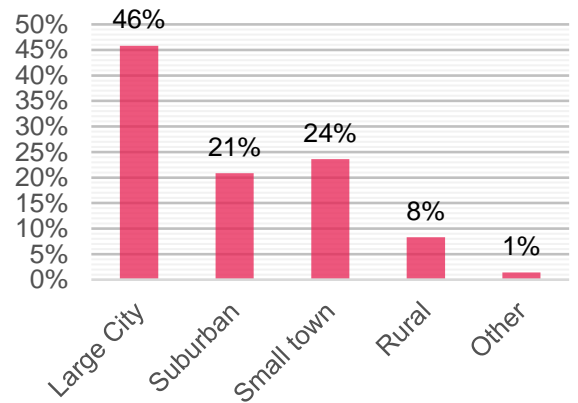
Age Group



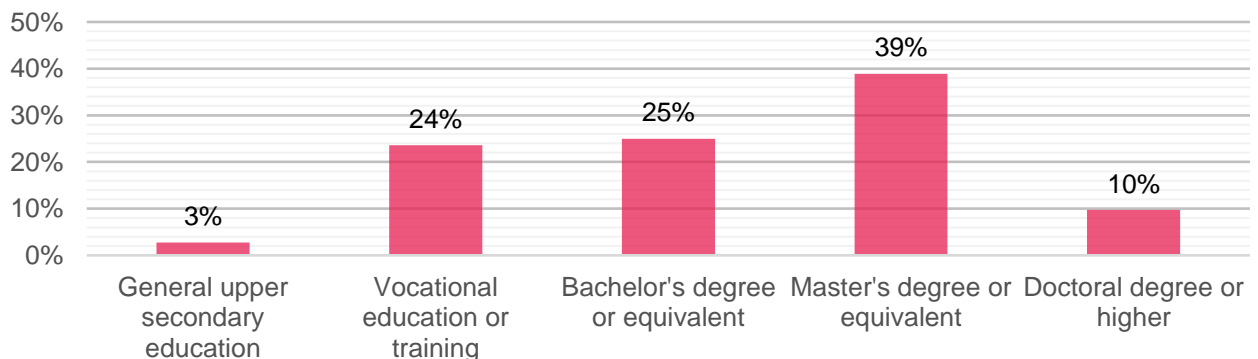
Gender



Area of Residence



Education



The survey received answers from at least 8 different countries, with Denmark coming in at the top with 44% of the total answers. Following this, Lithuania accounted for 12%, followed by both France and Norway with 10% and Estonia, Isle of Man, Latvia and Portugal each representing 1% each. 18% of respondents chose not to disclose from which country they came. Citizens from both Central and Eastern Europe, Northern Europe, Southern Europe, and Western Europe have answered the survey indicating a diversity across Europe.

These specific demographics may influence the answers and tendencies described in the report. However, when reading through the responses it is important to be aware that these results are not statistically representative, but indications of people's individual opinions which can be used as valuable input to the further work of the company's robot solution.

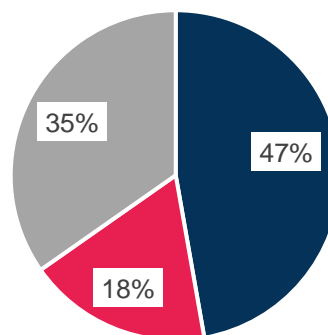
## Survey Results

**Question 1: Imagine that you are working alongside this robot. Would you prefer that it always moves on predefined paths (and simply stops when something gets in the way) or that it moves more flexibly, like a person would?**

Almost half of the respondents would prefer the robot to follow predefined paths clearly marked on the floor. This might be more predictable when working with the robot, and you do not have to wait for the robot to navigate around the workers. 35% of the respondents would prefer for the robot to plan its paths and navigate freely, even if it's less predictable. The last 18% of the respondents would prefer for the robot to follow a predefined path, but these do not necessarily have to be marked on the floor.

Looking at the elaborated answers there is a wide variety of answers to whether the robot should follow predefined paths for security reasons, and to wanting the robot to be as advanced as possible. Some respondents who choose predefined paths, have elaborated their answers, and understand predictable paths as being safer and mitigating the risks of injuries, while one respondent suggests having the robot move on a predefined path but with the technological advancement to move around obstacles. Other respondents expressed how having a robot following predefined paths is at a too low level of ambition as these robots already exist.

Imagine that you are working alongside this robot. Would you prefer that it always moves on predefined paths (and simply stops when something gets in the way) or that it moves more flexibly, like a person would?

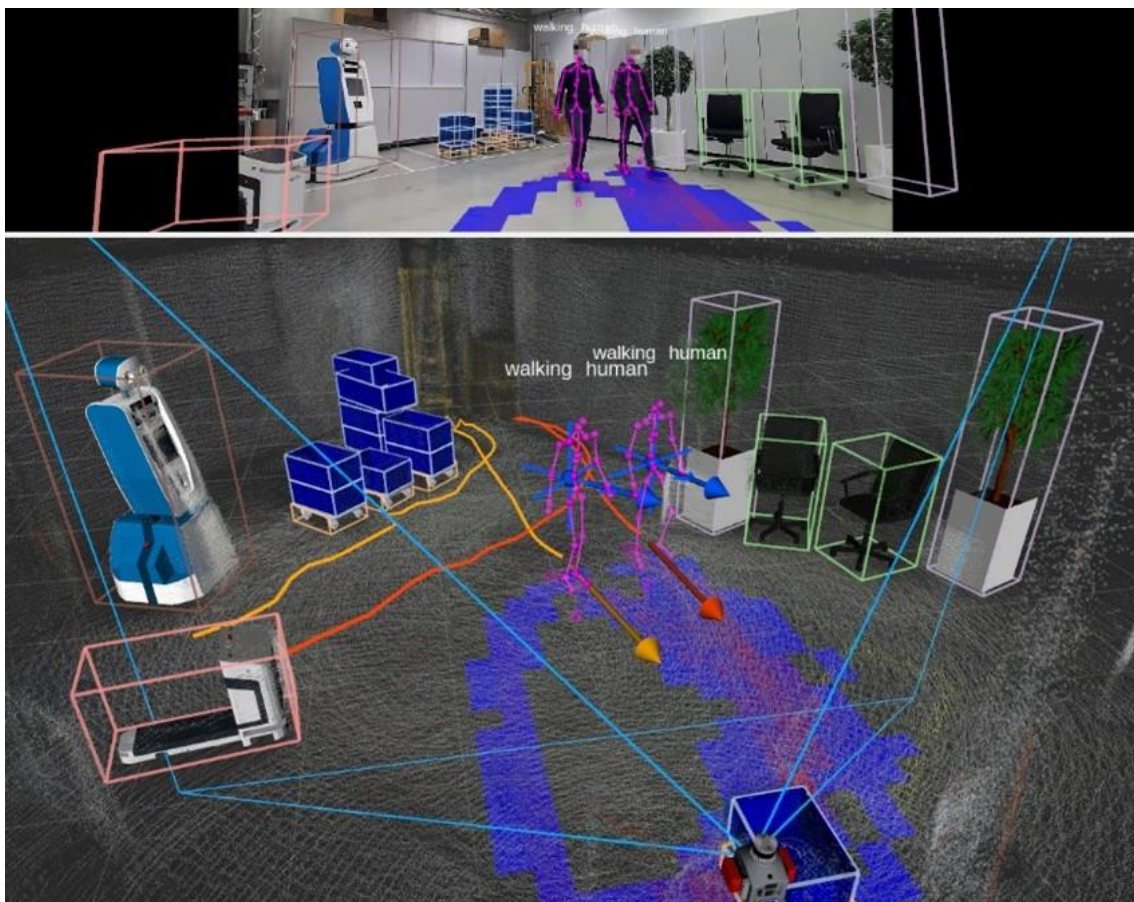


- I would prefer that it follows predefined paths that are clearly marked on the floor
- I would prefer that it follows predefined paths, but not necessarily marked on the floor
- I would prefer that it can plan its own paths and navigate freely, even if that makes it less predictable

So, to be in competition with existing robots the robot should be able to move freely and have a higher technological level as this is expressed as more effective by some of the respondents. This wide range of contrasts within the answers emphasises how different expectations to/of technology exist among the respondents.

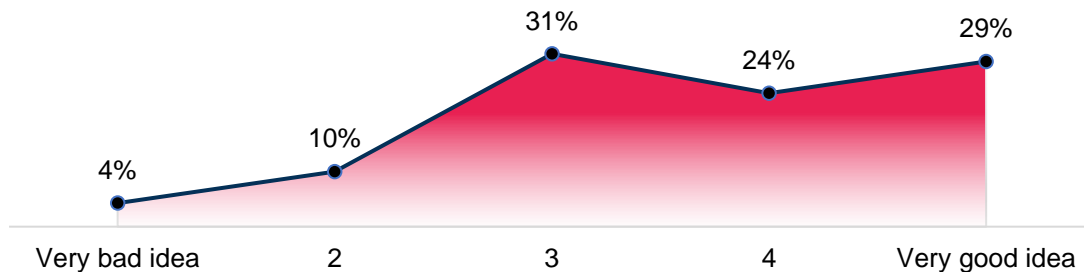
**Question 2: Do you think it would be good if the robot could adapt to its surroundings, for example by learning human activity patterns, and drive a longer path if that causes it to be less in the way of humans?**

To explore whether the respondents thought it would be a good idea for the robot to adapt to its surroundings they were presented with the following images showcasing how the robot can perform tracking through cameras to detect people around it and predict how they will move. The purpose of this is to increase safety for the people around it, and to interact more naturally with them.



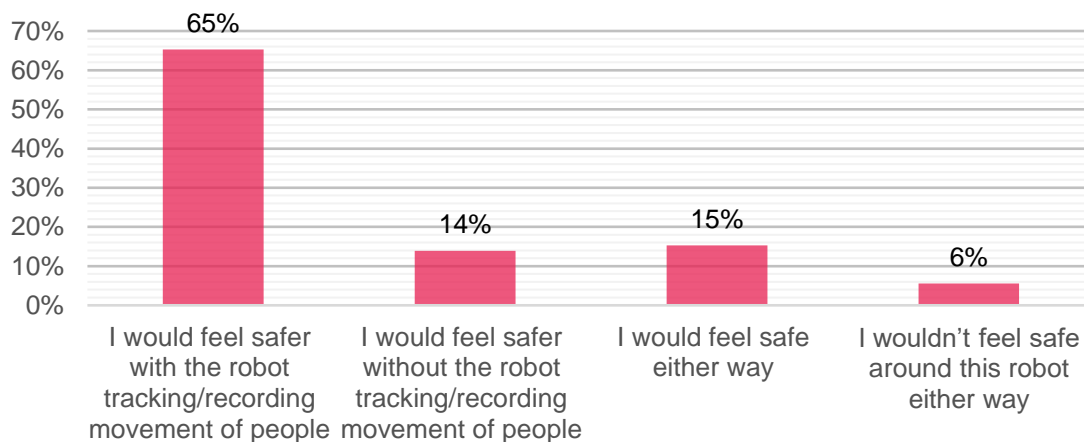
The respondents were asked to answer on a 5-point scale whether they thought it would be a good idea or a bad idea. More than half of the respondents are positive to the idea. About a third of the respondents choose the middle ground which can be an indication that they might be unsure about the idea of the robot adapting or that they are having difficulties understanding the question or technology presented. Only 4 % think it's a bad idea and 10% are less keen to the idea. The results can be supported by the hesitations towards the robot in elaborative answers expressed in question 1.

Do you think it would be good if the robot could adapt to its surroundings, for example by learning human activity patterns, and drive a longer path if that causes it to be less in the way of humans?



**Question 3: Would you feel safer/more comfortable working along a robot that tracks the movement of people such as described above, or one that doesn't record the movements of people around it?**

**Would you feel safer/more comfortable working along a robot that tracks the movement of people such as described above, or one that doesn't record the movements of people around it?**



65% of the respondents said they would feel safer with the robot tracking/recording movement of people. This result can be supported by the former question where more than half of the respondents thought it was a good idea for the robot to adapt to its surroundings. Within the elaborated two respondents emphasised why they prefer to have the robot adapting to its surroundings: *“It increases the reliability of the robot but also it will be able to adapt to us and not the reverse”* and *“So I know that the robot can at least partially adapt to me, and therefore that I must not do all the work of adaptation”*.

14% of the respondents would feel safer without the robot tracking/recording movement of people. Some of the respondents have elaborated on why they do not feel safer with tracking technology: *“[...] Personally, in the situation of the photo I would not just feel comfortable. Being against it, if the robot is heavy or can grind my hand, I will not feel safe”*. And another respondent expressed concerns regarding data protection: that *“there is a risk of personal registration”*.

The comment highlights the complications that can occur when having the robot track/record its surroundings, and to why some might feel uncomfortable with the management of the data being collected. However, another respondent in favour of the tracking technology argues that “[...] *The privacy issues implied in the question can be addressed independently.*”

There are also a variety of comments concerned of the robot’s technical ability to track the movement of people, and how well it can do this: *People are different, and are often replaced in workplace so it can be complicated to learn what 'people' do* “ and *“I don't think humans are so programmed that we all act the same and I don't think we're at a level of development where it can succeed with a robot.”* For some there is a mistrust in the technology being mature enough to adapt to complex environments and unpredictable movements. This is a barrier worth paying attention to, because even though the technology might be ready there can still be a lack of trust from humans.

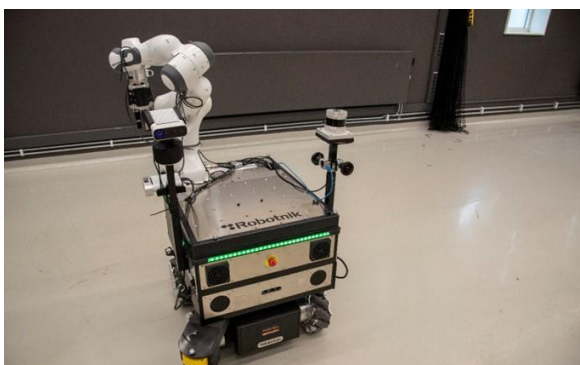
Another respondent mentions concerns regarding the technical maturity level: *“I don't think man is so programmed so it acts the same and I don't think we're at a level of development where it can succeed with a robot”.*

15% of the respondents would feel safe either way. This result can reflect how the question can be difficult for the respondents to imagine a scenario of them working along with the robot, and why they might not have a strong opinion towards a robot tracking movement. Lastly only 6% of the respondents said they won’t feel safe around the robot either way.

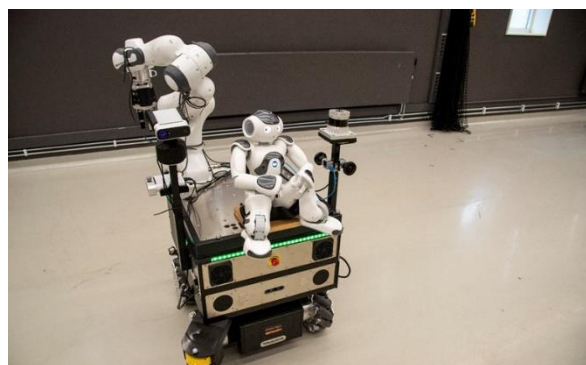
### Testing different levels of communication

To explore the use of different levels of communication the respondents were presented to two different prototypes of the robot and asked to react to three of the same statements.

The first robot presented was a picture of the current appearance of the robot in the developing stage it is in now. The second robot presented was a picture of the same robot but now with the humanoid looking robot NAO (from SoftBank Robotics) on top of the DARKO robot. This was done to test whether some of the functionalities of a humanoid looking robot can have a positive impact on peoples first impression of a robot or if it is indifferent to their feelings towards it.



Robot 1 in its current appearance



Robot 2 with a humanoid robot



The respondents were also informed that they should be aware that the addition of NAO was only to test a concept and not necessarily how the developers envision the final product.

The respondents were asked to react to three statements indicating on a scale from 1-5 how very high or very low they expected to do the following:

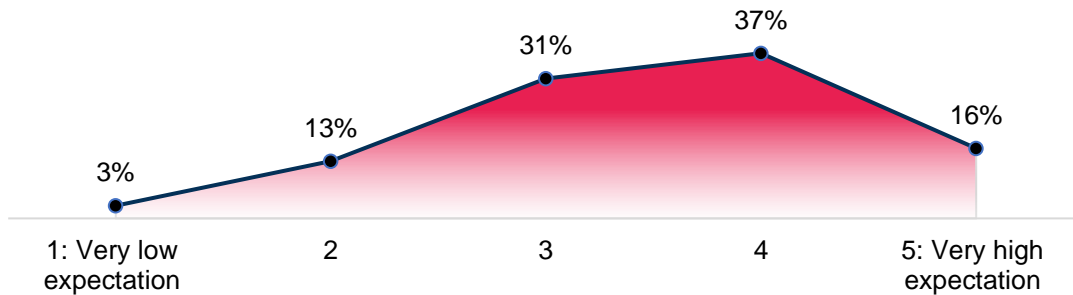
- 1) I think I will be able to interact well with this robot
- 2) I would find this robot trustworthy
- 3) I would like to work alongside this robot

In the survey the respondents were first asked the above questions for the first robot and then they were presented with the second picture of the robot and asked the same questions again. In the report, we will however present one question at a time and then compare the responses of the two robots.

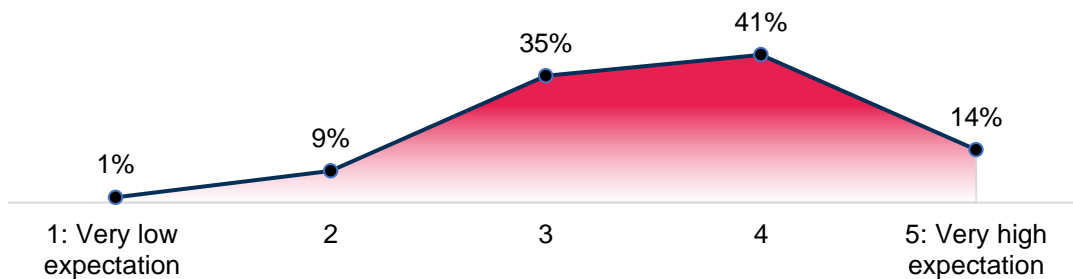
**Question 4: I think I will be able to interact well with this robot**

To explore the use of different levels of communication when interacting with the robot, the respondents were asked to indicate on a scale from 1-5 how very high or very low they expected to interact well with the robot. Below you can see the results from the two robots presented.

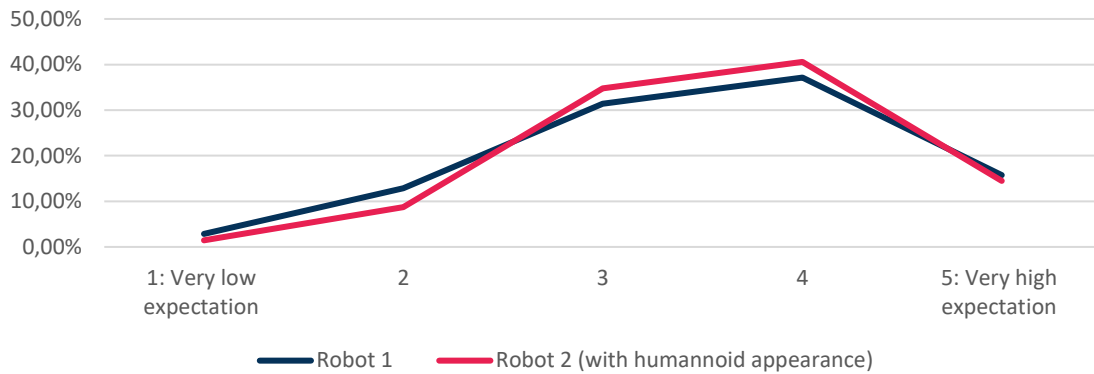
**Robot 1: I think I will be able to interact well with this robot**



**Robot 2: I think I will be able to interact well with this robot**



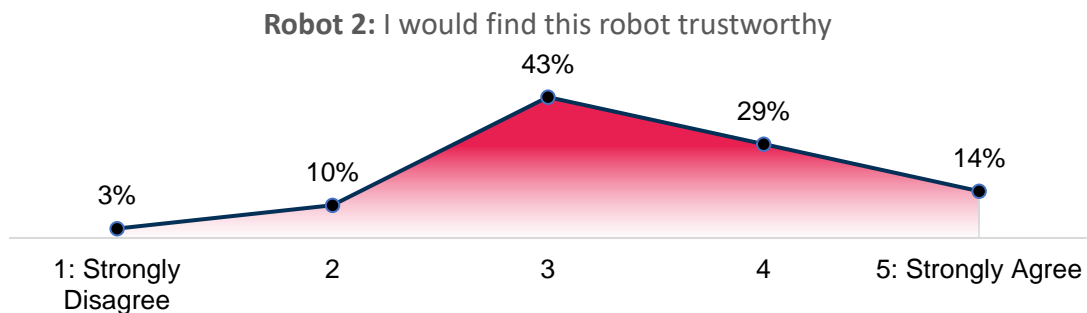
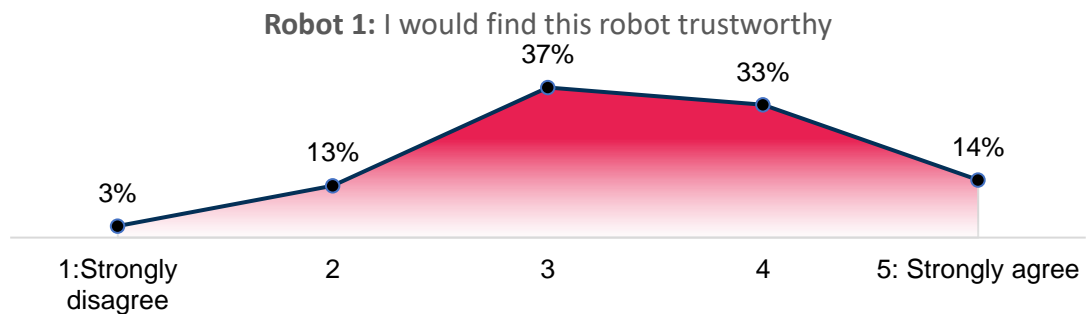
### Q4: Gathered for comparision



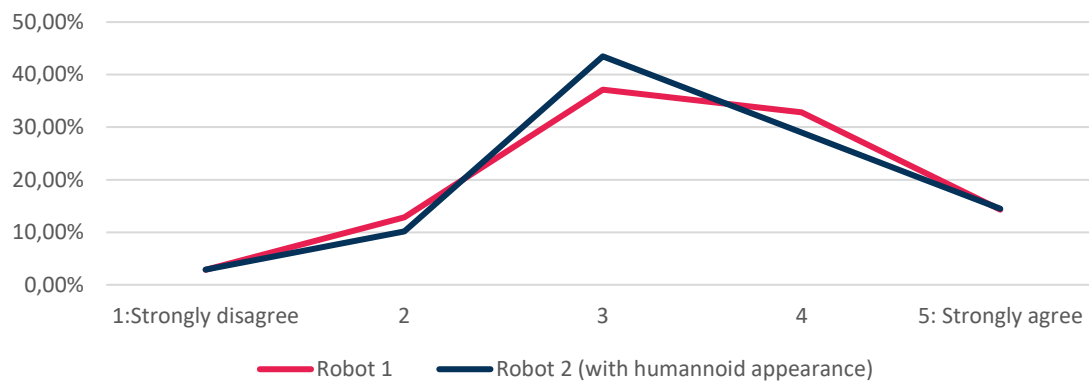
As can be seen from the comparison there's only a small difference in the respondents' answers. Robot 2 with the humanoid appearance scores marginally higher having fewer people answer that they had low or very low expectations towards interacting well with the robot but at the same time it also scores slightly lower in the other end of the scale with the very high expectations. Because the margin is so small and taking the number of respondents into consideration the result implies that the respondents generally are positive towards interacting with the robot regardless of the humanoid features brought by the NAO robot.

### Question 5: I would find the robot trustworthy

The respondents were asked to enter on a scale from 1-5 how strongly they agreed or disagreed to the statement of finding the robot trustworthy.



### Q5: Gathered for comparriosn

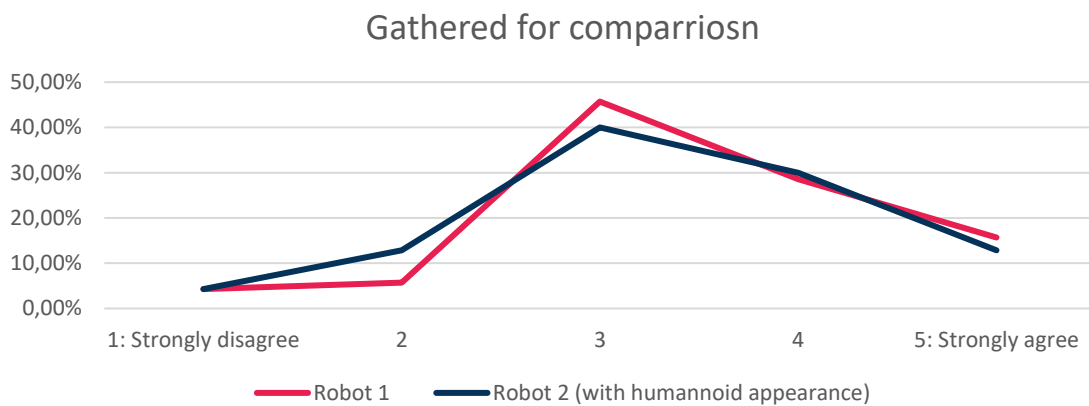
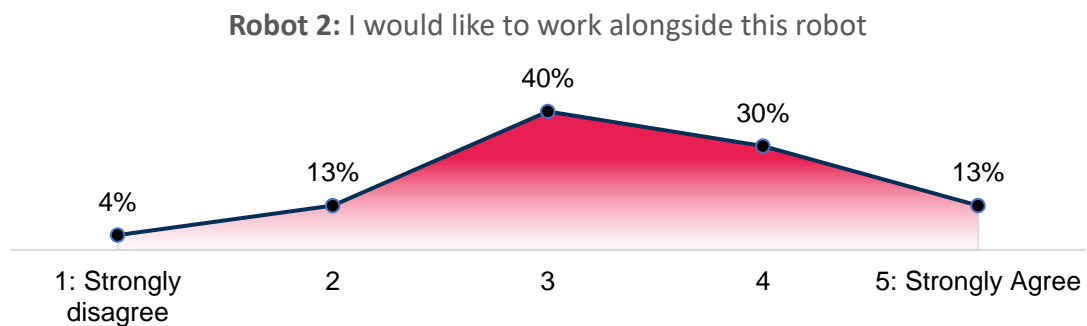
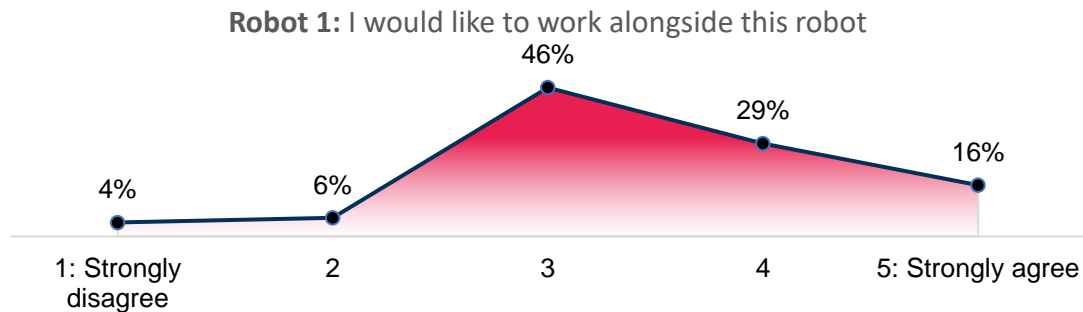


Once again, the results are very close to each other, the number of respondents strongly disagreeing to the statement are identical and the same goes for the number of respondents strongly agreeing to the robot being trustworthy. While respondents entering their score in the middle of the scale are a little higher towards the humanoid robot, this might be linked to the respondents being a bit more unsure how they should feel towards the humanoid robot not knowing what it can and can't do. It can therefore not be concluded whether giving the robot a face can generate a feeling of security and familiarity. However, this is something that could be further explored with real-life testing with regular citizens where they can get a better feel of the robot and explore it better than what can be done through a picture.

A focus group interview conducted among the participants of the Robotex International festival reveals that it is difficult to evaluate rudimentary robots and their functions when the first impression is of a machine in a very early stage of development. Trust is created by the need to see that the robot is mature. "The first thing that strikes me about him is that he is, as it were, at an early stage in its development. It is hard for me to understand what he is made for and what he does. Even if there is a description, the first feeling is that it is still too raw."

**Question 6: I would like to work alongside this robot**

On a scale from 1-5 respondents were asked to enter how strongly they would disagree or how strongly they would agree to like working alongside the robot.



Once again, the results are very similar but here the respondents were a little more positive about working alongside the robot without the small humanoid robot on top of it.

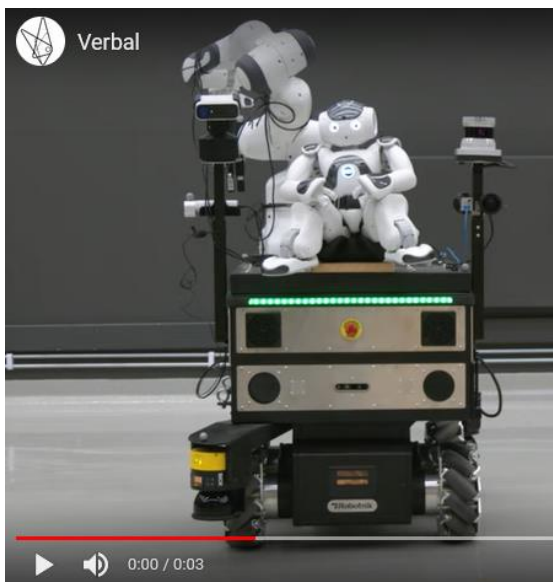
Looking at the results from the former 3 questions most of the answers were placed in the middle of the scale ranging from high expectations to low expectations and from strongly disagreeing to strongly agreeing. The distribution of the results is expected with conceptual questions where the respondents still haven't experienced in real life the situations they are being asked to respond to. The first 2 comparisons most of the respondents had a slightly lesser negative response to have the little humanoid robot on top of the robot, while with the last comparison a small margin of the respondents preferred working with the robot without the humanoid robot.

Looking back at the former questions in the survey, the respondents have expressed they preferred having the robot adapt to the human's contra having the humans doing the adaptation. So, when the robot is doing most of the adaptation this can potentially help with the trust building towards the robot. Given a situation where they must work alongside the robot it does not seem to be as important to have a humanoid robot sitting on top.

### Testing of verbal and gestures as means of communication

To further test the functionalities a humanoid robot can provide, the respondents were introduced to two videos of the robot with NAO in function. The first video has NAO informing its intentions by using a voice saying, "let's go to goal number 5".

In the second video presented to the respondents, NAO informs its intention by using the same voice and a gesture by looking and pointing in a direction.



Video 1 (only verbal)



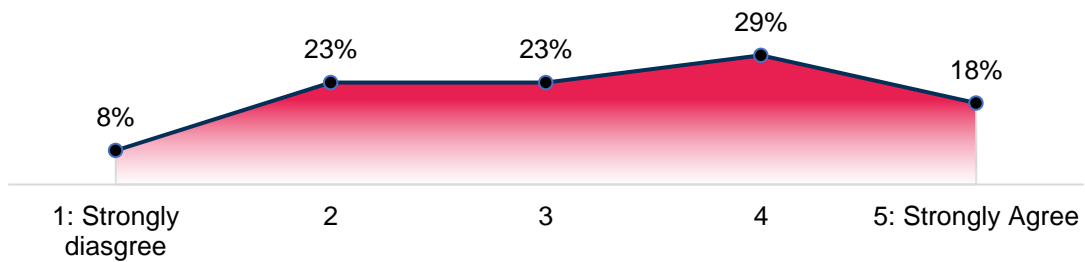
Video 2 (Verbal, Gesture & Gaze)

Respondents were asked both how strongly they agreed or disagreed with the robot clearly communicating its intentions and whether they thought this was appropriate way to communicate where the robot will go next on a scale from 1-5.

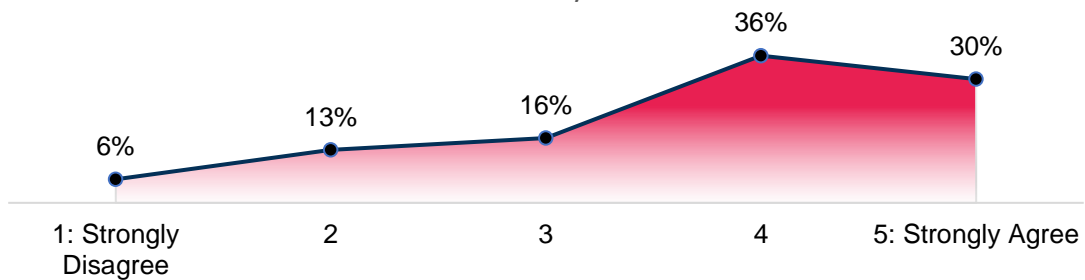
**Question 7: Did the robot communicate its intentions clearly?**

Looking at the results below the respondents were more prone to having the robot communicating its intentions by using both a voice and gesture. In the first video only 47% of the respondents agreed or strongly agreed that the robot communicated its intentions clearly, whereas in video 2 66% thought the communication was clear. Also, in the middle and the other end of the scale we see a clear difference between the two. However, we can also conclude that there still is a group of people who do not think the robot is clear in its communication one way or the other.

**Video 1 (verbal):** The robot communicated its intentions clearly.



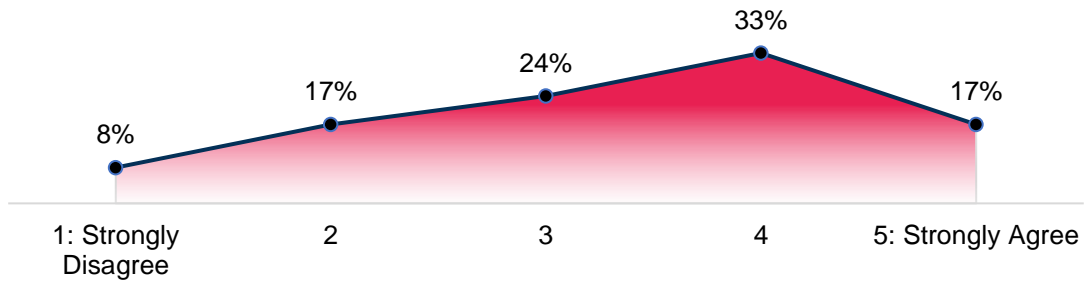
**Video 2 (Gesture & Gaze):** The robot communicated its intentions clearly.



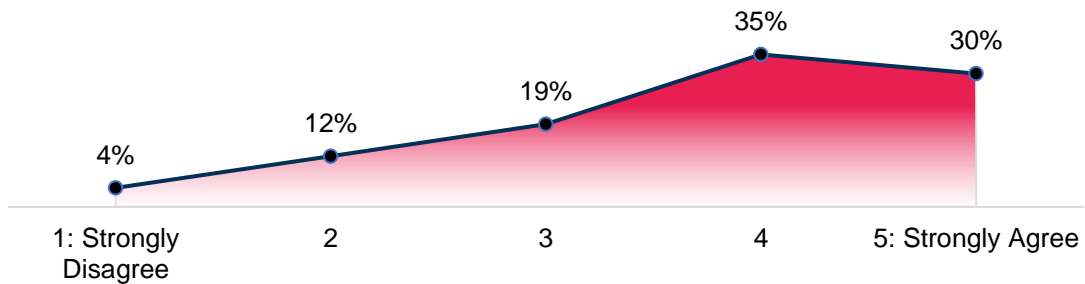
**Question 8: Do you think this is an appropriate way to communicate where the robot will go next**

The respondents are again introduced to two videos, one with the robot communicating by using a voice and one video with the robot communicating using a voice and gesture.

**Video 1 (verbal):** This is an appropriate way to communicate where the robot will go next.



**Video 2 (Gesture & Gaze):** This is an appropriate way to communicate where the robot will go next.

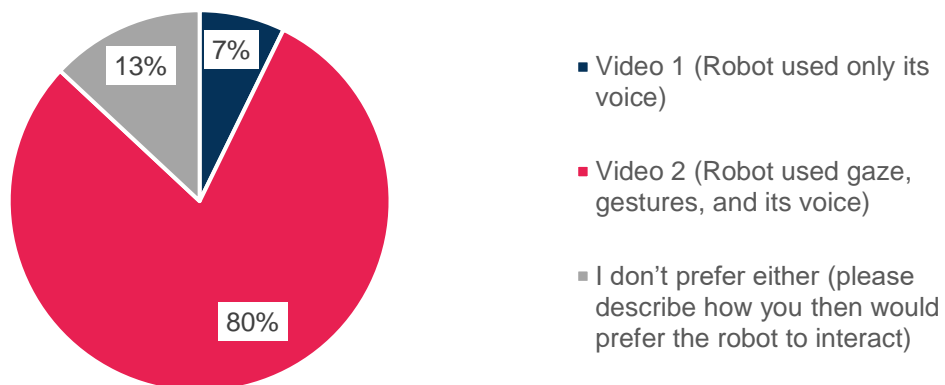


The results are similar to the former question. The respondents are more prone to having the robot communicating by using a voice and gesture. A higher number of the respondents disagree with communication being an appropriate way of communicating, when only using a voice to inform of where the robot will go next. Almost twice as many strongly agreed to having the robot use bot the voice command and gesture compared to only using the voice. Looking at the two previous questions we can conclude that there is an indication that the respondents would rather have communication in more than one way. In addition to this people with hearing or visual impairment should potentially also be considered.

**Question 9: If you were to work together with this robot, which type of interaction would you prefer, based on the two videos you have seen?**

Lastly the respondents were asked to evaluate which type of communication with the robot they preferred. They needed to answer if they wanted the robot to communicate using its voice or by using its voice along with gestures. If they didn't prefer either, respondents could describe how they wanted to interact with the robot.

**If you were to work together with this robot, which type of interaction would you prefer, based on the two videos you have seen?**



80% of the respondents preferred the robot to communicate by using a voice and gesture. While 7% preferred the robot to use its voice to interact. 13% of the respondents didn't prefer either way of interacting with the robot.

Looking into the elaborative answers one respondent mentions how: *“we perceive differently, so therefore good with different actions”* supporting why using a gesture along with the voice is preferred. Some of the respondents do have reservations towards the voice being used. The voice needs to be clearer and asked for it to be in a more serious tone. Other respondents are asking for the use of led light for the robot to communicate where it is going. While another respondent mentions how humans do not communicate which directions on where they are moving, so this might not be needed with a robot. With this comment it should be considered that humans do use a lot of indirect body language and mimics that can show our intentions, which the robot does not have. To mimic this the robot can perhaps be accommodated by using lights, a display on the robot or by placing the humanoid robot on top of the robot by communicating its movements with gestures. One answer stands out from the others: *“it is easiest with only one indication”*, the comment separates itself from the other comments and the 80% preferring the robot to communicate using different approaches. The Comment might be in relation to the former comment on humans not explicitly expressing their movements, and therefore the communication might not be necessary.



## Conclusion

The results provide insight into the diverse opinions and expectations of technology among respondents. The results suggest that safety concerns and technological advancement are factors in determining preferences for the robot's movements, with a majority of respondents preferring the robot to adapt to its surroundings and learn human activity patterns for increased safety. The results also show that many respondents would feel safer working alongside a robot that tracks and records the movement of people, but there are also concerns about data protection and technical ability that need to be addressed if doing so. The results also indicate that the addition of humanoid features to a robot does not have a significant impact on the respondents' willingness to interact with the robot or their perception of its trustworthiness. However, the use of both verbal and gestural communication improves the clarity and acceptability of the robot's intentions. The results suggest that the majority of respondents prefer the robot to communicate using a voice and gesture, and that it is important to consider the needs of people with hearing or visual impairments when designing communication for robots. Overall, the survey highlights the importance of considering the diverse perspectives and needs of individuals when developing technology and the need for further testing with real-life interactions to fully understand the impact of the DARKO robot's features on human-robot interactions.

# consortium

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