



# RobStruct

*Citizen Survey Results*



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## Introduction

This report presents the results of a collaboration between RobStruct (DK) 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.

## RobStruct

RobStruct is a Danish construction technology startup that develops applications for mobile robots, with the intent of implementing them in the construction industry. Their solution is based on the idea that it is possible to alleviate the pains construction companies experience with regards to worker health, workforce shortage, and sub-optimal productivity.

For example, this type of robot can be connected to a trailer that can help move large and small objects on construction sites such as bricks, tools, waste etc.

The solution is built on the idea that it is possible to create mobile robots that are intuitive to use and adaptable to their environment and the tasks they are set to perform.



At the core of RobStruct's philosophy is the need for improving worker health by alleviating the construction workers from repetitive and physically demanding tasks such as continuous lifting, carrying, and towing.

By eliminating non-value-creating and time-consuming tasks via autonomous executing, RobStruct solutions enable construction staff to focus on actively building. Their solution aims to increase productivity and improve the mental health of workers.

## Demographics

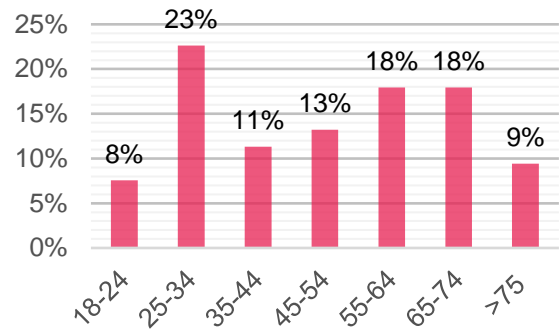
The survey received a total of 106 responses. The survey received a well distributed number of respondents from most age groups. Citizens in the age groups 25-34, were best represented accounting for 23% of the total responses. These were followed by the age groups 45-54 and 55-64 each accounting for 18%. The age group least represented was the young people between 18-24 with 8%.

The gender distribution of citizens had a higher distribution of males accounting for 59% whereas the females accounted for 39%. The remaining either answered 'other' or did not specify their gender.

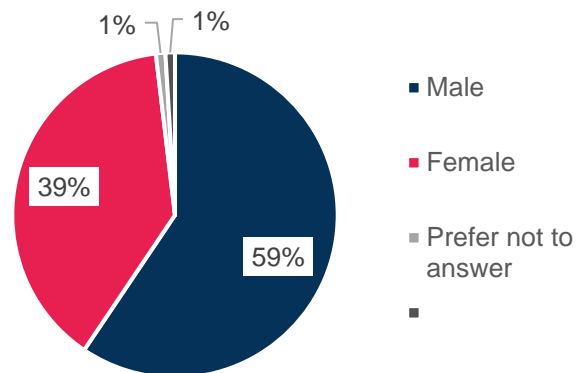
Looking at distribution of areas of residence, a total of 45% of the participants answered that they lived in a large city. The second most chosen option was small town with a total of 26%, followed by suburban with 21% and rural with 7%.

Participants were generally highly educated with 74% answering that they held either a bachelor, master's degree or higher, whereas only 24% held primary, secondary or vocational education.

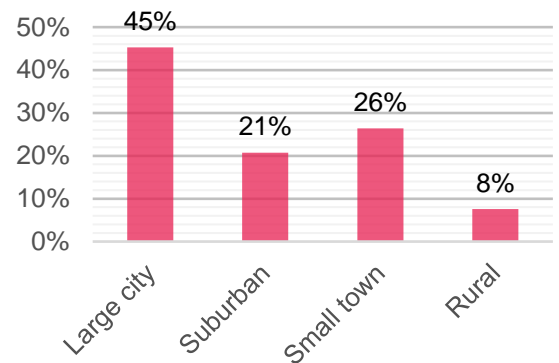
Age-Group



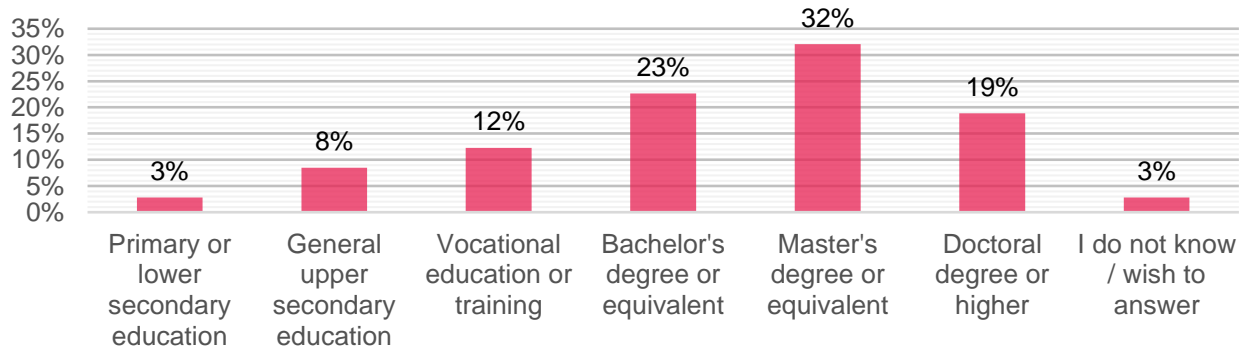
Gender



Area of residence



Education



The survey received answers from participants from at least 13 different countries. However, 21% chose not to disclose their country of origin making it difficult to give exact information on where respondents participated from. But 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

Citizens were asked six questions regarding their perceptions of the robot, exploring the robot-human interaction at a construction site. Additionally, the questions explored what opportunities there might be for a robot like RobStruct, but also evaluating potential barriers towards the robot.

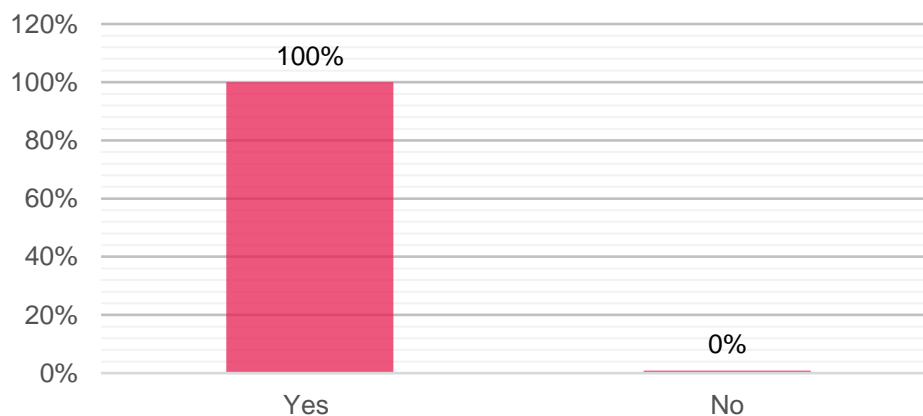
To set the stage, the citizens were put in the following imaginative scenario and asked to answer questions based on this:

***Imagine that you are working at a construction site, and you meet your new coworker. It is a mobile robot capable of helping you with multiple daily tasks. The robot can transport equipment, waste, and a wide array of building materials and it can find its way around the site on its own.***

### **Question 1: Do you think working alongside a robot which is able to move objects could be beneficial and useful at a construction site?**

All of the respondents agreed that it would be beneficial to work alongside a robot which can help move objects while working.

**Do you think working alongside a robot which is able to move objects could be beneficial and useful at a construction site?**



Looking at the elaborative answers it is clear that the citizens see great value in freeing construction workers from doing repetitive and physically demanding lifting-jobs to hopefully reduce wear and tear on their bodies over time and improve their work conditions. One respondent said *“It will increase the time that construction workers can spend on constructing, as well as improving safe work conditions, and inspecting buildings, making sure that every procedure is being followed.”* which was backed up by several others *“[it] Would lead to better concentration on important tasks rather than item logistics.”* and *“Yes, the wages of the workers on the building sites are already low, if technology can help their daily work, why not!”*.

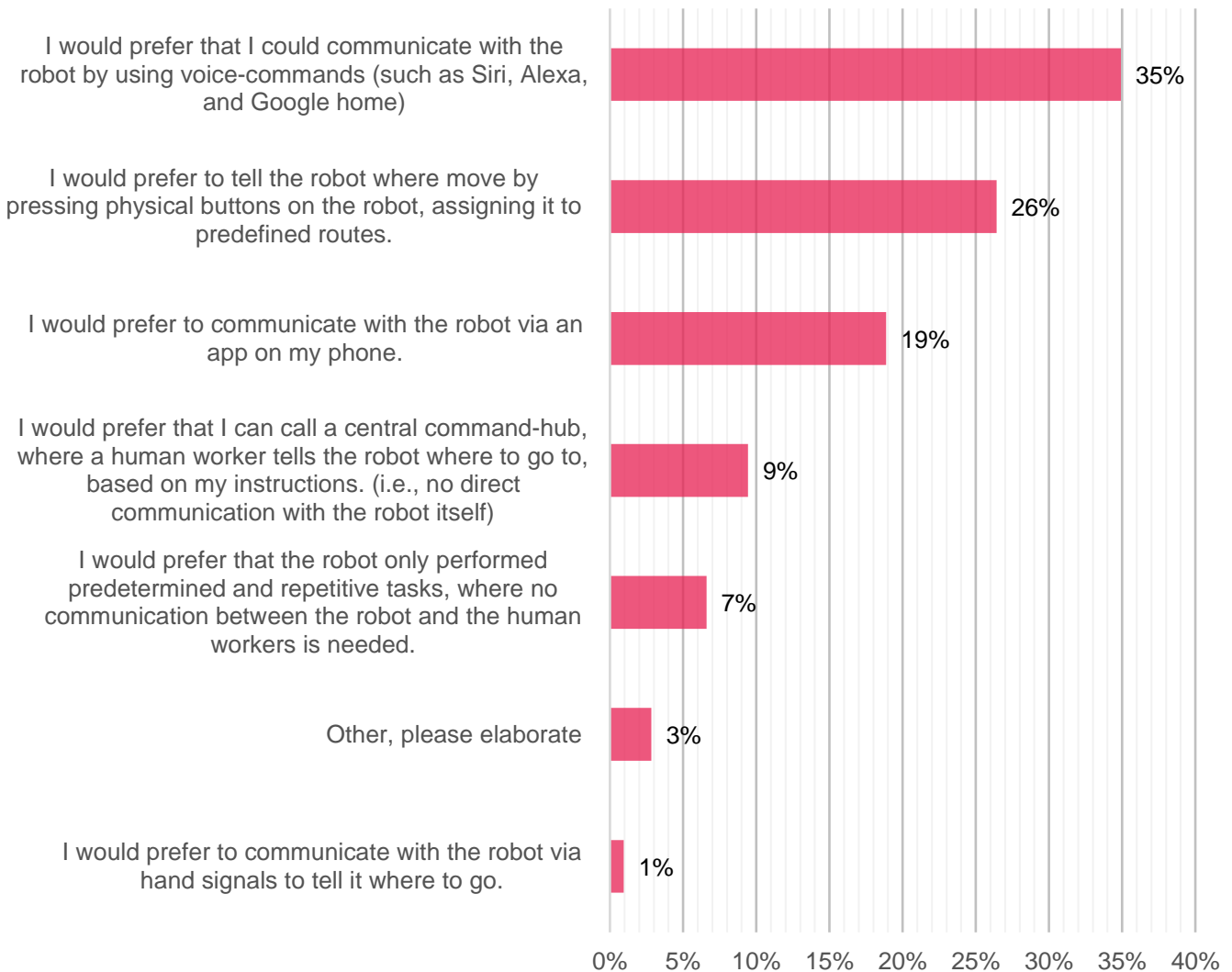
A few respondents did however question the functionality of the robot, although they in general agreed to it being useful. One found it difficult to see how the portrayed robot could deliver significant help and value based on the pictures the respondent had been presented with and another respondent feared that the robot might be in the way and have people bumping into it or stepping on it, *“I’m already afraid of walking on it.”*. Taking the elaborative answers into consideration there is an indication that the intended idea behind the robot is good but further work on applying real life use cases to the robot will enhance the perception of the robot and ensure it gives the added value to a construction site. It is important to bear in mind that the citizens were only portrayed with pictures of prototypes as the robot is still in its developing stage.

Participants in the focus group interviews conducted during the Robotex Festival also pointed out that the robot seems ineffective for the given tasks. *“Useful in some ways, just a waste in others. He’s so small.”*

**Question 2: You have just loaded the trailer attached to the robot with waste, and a specific tool that your human coworker on the opposite side of the construction site needs. How would you prefer to tell the robot what to do?**

To help the developers get insights on how the robot-human interaction can be designed the citizens were asked to give input on how they would like to communicate with the robot in the imaginary scenario.

**How would you prefer to tell the robot what to do?**



The responses indicate that the preferred means of communication to the robot is either by using voice-commands or by interacting with an interface on the robot such as physical buttons. Only a few said that they did not want to have direct contact with the robot, answering that they would prefer a central command-hub or that the robot only did repetitive tasks where no communication is needed. Among those who choose voice commands it was explained that this would be a more fun way of communicating and that *“This type of technology is widespread, and well tested. People are familiar with it, making it easier for recently hired employees.”*



Among those who chose to communicate through a physical interface such as buttons their reasonings were mainly because of practical considerations of the work environment not being ideal for technologies using voice commands because of loud noises: *“The construction sites are dirty and noisy environment, the use of physical buttons seems to me to be the most rational and the most comfortable”* and *“this makes it possible to compensate for the noise present on the site (inappropriate voice command), I think it is necessary, otherwise we lose the interest of this new colleague, to be able to communicate directly with him)”*.

Those who choose to communicate via an app on the phone highlighted that this would be ideal because then the human would not have to be near by the robot. However, others had concerns towards using an app underlining that *“If the employee has personal protective equipment (gloves, helmets, fuses, masks) on the construction site, then the use of a mobile phone may take more time than the touch of a button”*. Another respondent also highlighted that it is important that the use is adapted to the work situations and that having an app would just be an additional means of communication they had to carry around.

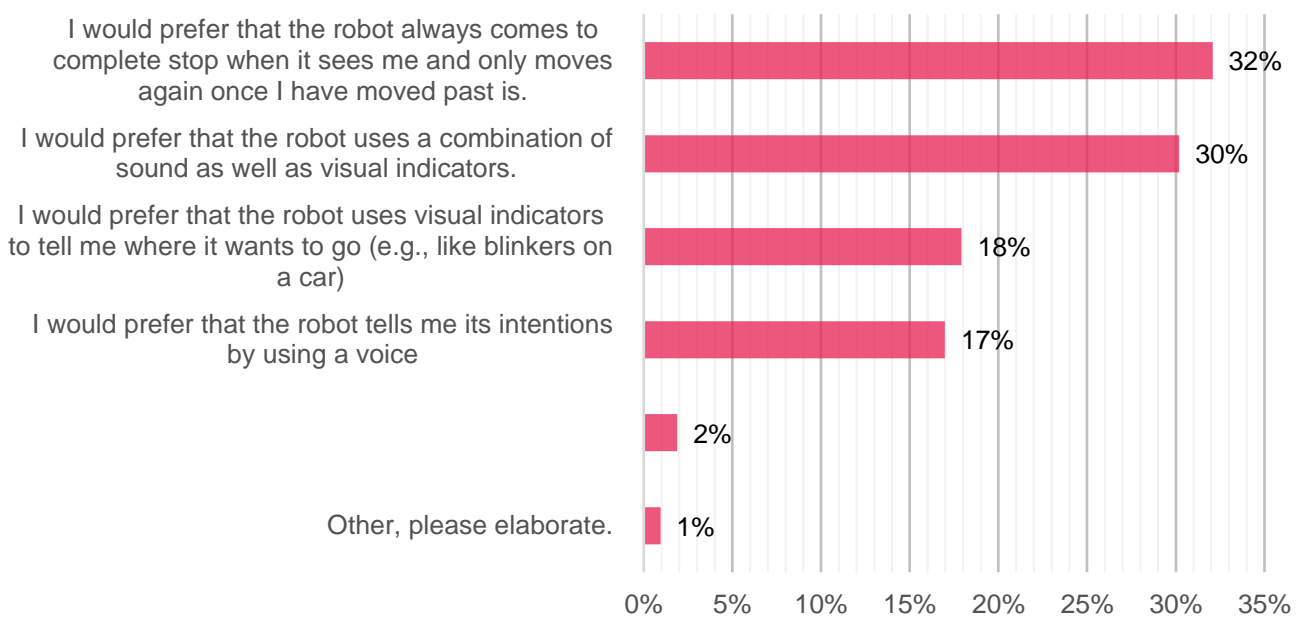
Looking at these responses is not only interesting from a design perspective, but they also give a small indication that there is a general trustworthiness towards the robot and willingness to collaborate with a robot and give it instructions. The citizens seem confident that they will have the skills and be able to communicate with a robot and only 16% preferred to communicate through a human command-hub or not to communicate at all with the robot.



**Question 3: Later that day, you encounter a robot delivering materials on a narrow path. You are unsure if you should step to the side or if the robot will navigate around you. How would you prefer that the robot communicates its intentions to you?**

To explore how the robot can navigate comfortably around a construction site both for the humans it encounters and the robot itself the citizens were asked to choose between different ways the robot potentially can indicate its intentions. In the diagram below the options and distribution of answers are shown.

**How would you prefer that the robot communicates its intentions to you?**

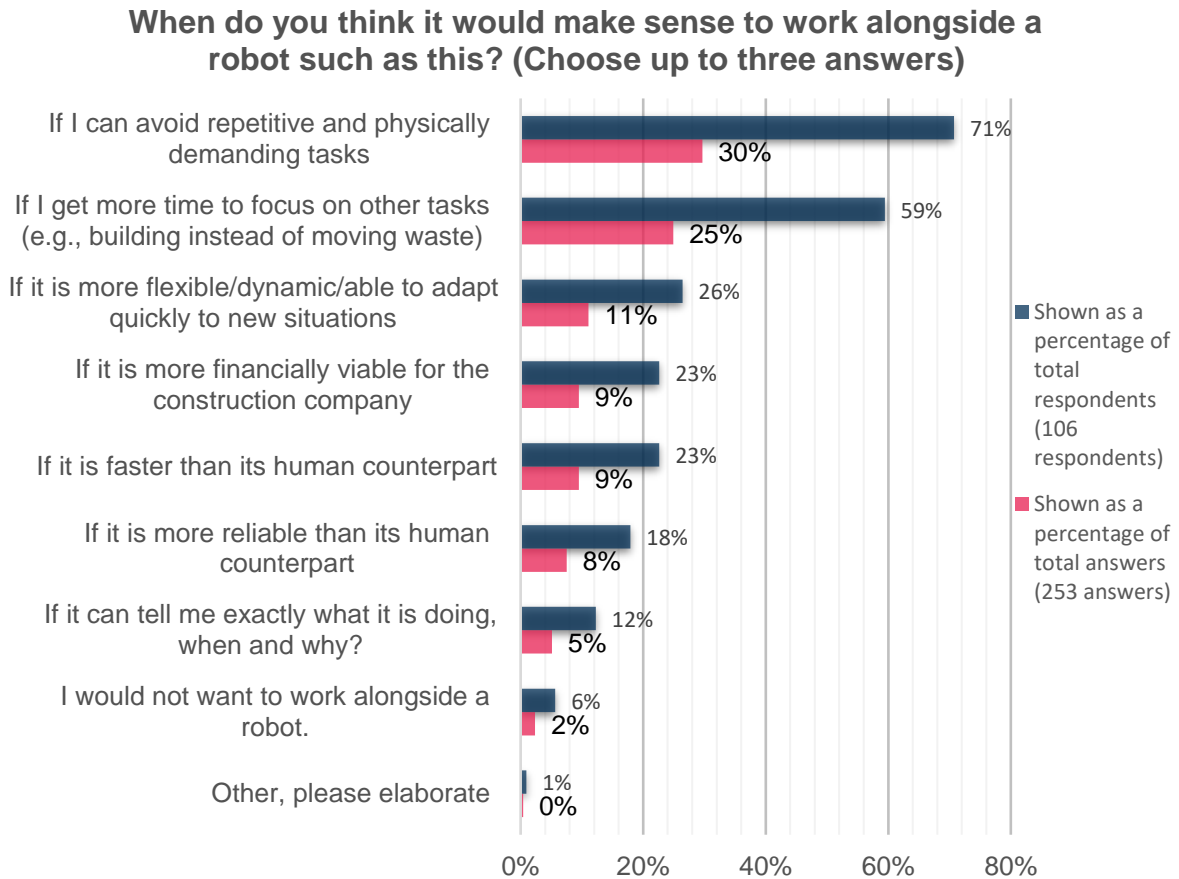


Approximately two thirds of the respondents preferred to have the robot show its intentions either via visual indicators (18%) sound indicators (17%) or a combination of both (30%). Among the elaborative answers, respondents suggested that because construction sites can be in a loud and perhaps unpredictable environment it is important that the robot can use multiple modes of communication. One suggests loud sounds and some kind of visual indication such as an arrow to show the robot's trajectory. Accessibility was also mentioned by two people as something the design of the robot should consider.

There was also a large group (32%) who preferred the robot to come to a complete stop. One respondent mentions that this will be the safest and most reliable and another points out that *“in construction it is often loud, and people could be wearing noisecanclers. It is best that the robot operate on the premise of the workers, not the other way”*. Ultimately determining what mode of communication most suitable for this robot cannot be settled in this kind of survey as it very much depends on the situation and use case of the robot, which was also pointed out by some of the respondents. However, the answers can give indications of directions worth considering in the further development of the robot.

**Question 4: When do you think it would make sense to work alongside a robot such as this? (Choose up to three answers)**

To get an idea of the value proposition of the RobStruct robot, the citizens were asked to choose up to three different incentives where they thought it would make sense to work alongside such a robot.



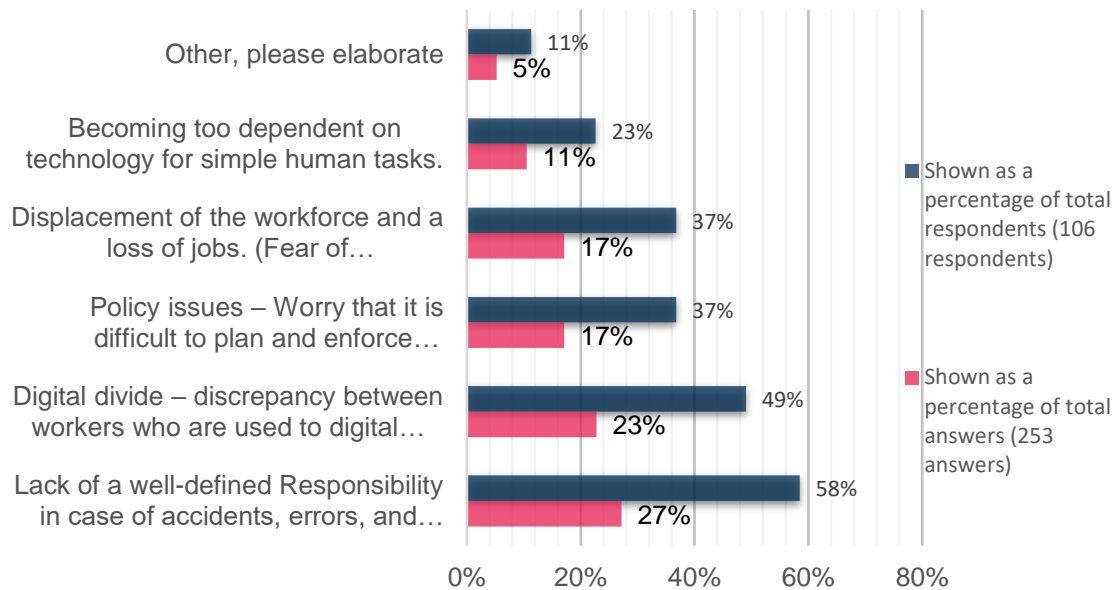
Looking at the answers it is clear that many think it makes sense to use such a robot in use-cases where it relieves humans in repetitive and physically demanding tasks and/or when it can relieve work to give them time to do other tasks such as building instead of moving. A few also choose that it would make sense to use such a robot if it could outperform its human counterparts in performing tasks such as being more flexible, faster or reliable.

Only 6% answered that they would not want to work alongside a robot. There seems to be a general acceptance towards robots working in places such as construction sites as long as they are well designed for the environment and can help relieve workers. We can see this as positive attitude towards the business potential of having a robot such as this working alongside humans.

### Question 5: What do you see as the largest barrier towards implementing automation in the construction sector?

To uncover some of the challenges towards implementing robots in the construction sector, the citizens were also proposed with five potential barriers of which they could choose up to three they found the most concerning.

#### What do you see as the largest barrier towards implementing automation in the construction sector?



58% of the respondents identified the lack of well-defined responsibility in case of accidents, errors, and flaws concerning the robot as one of the most concerning barriers. One respondent however pointed out that the *“lack of well-defined responsibility in case of accidents is easily preventable if regulations are being developed alongside the robotics.”* This then raises the question of who should be responsible for developing these regulations? Many (37%) also foresaw that policy issues might become a barrier, one respondent elaborated: *“everyone can get used to robots. But to enforce laws and policy is something that takes more time.”* There’s both a wish for regulatory actions but also a fear that this can be time consuming and ultimately slow down the technological advancements. The fear of digital divide and discrepancy between workers who are used to digital technology and workers unable to utilize digital technology was also chosen by more than half of the respondents. This goes well in hand with many also being concerned about displacement of the workforce and loss of jobs.

In addition to the given options, multiple respondents also pointed towards lack of mature technology or scepticism towards it being possible to develop robots that are agile enough to work in a complex environment like a construction site as the main barriers.

One respondent explained:

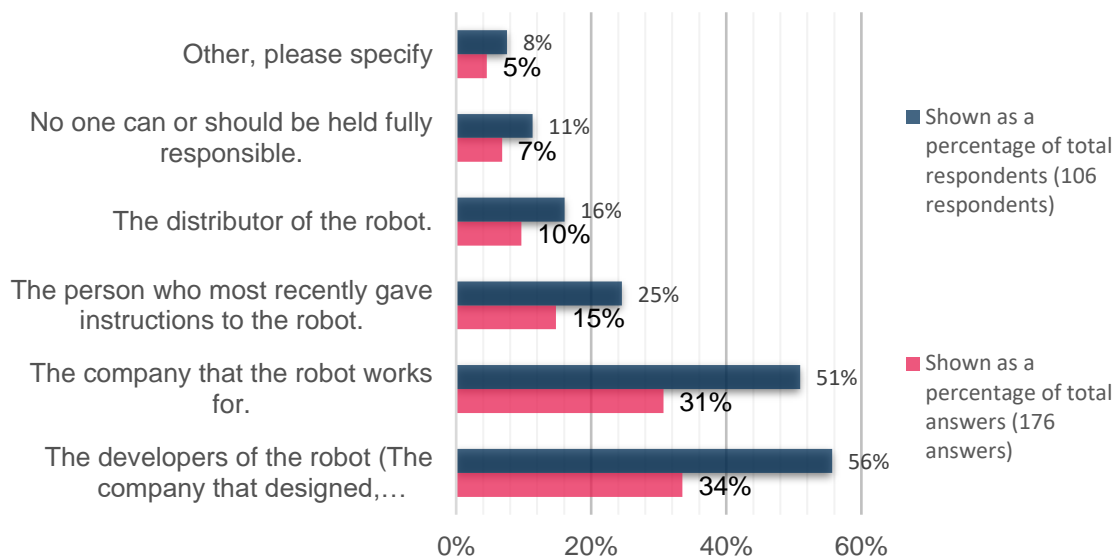
*“The robots simply aren't yet good enough for the complexity of our world. Where are all the self-driving cars that were promised...” and another: “The integration of robots into this sector will be more difficult, than for factory automation for example, because of the completely unstructured environment and wide variability.”*

Some simply think that the tasks at a construction site are too complex and dynamic for it to make sense investing in robot solutions.

**Question 6: Who do you think should be responsible if the robot makes mistakes, or causes accidents?**

To elaborate on the barrier of responsibility the citizens were also asked to give their thoughts on who should be responsible if the robot makes mistakes or causes accidents? The respondents could choose up to two answers.

**Who do you think should be responsible if the robot makes mistakes, or causes accidents?**



Here it was clear that the developers of the robot and the company/entrepreneur that bought the robot to use it at the construction site should be the two main responsible actors. Looking at the elaborative answers, two of the respondents compare it to how we determine responsibility for malfunctions with the vehicles we use every day, where car and plane manufacturers are held accountable for any type of malfunctions or accidents that are not related to the human controlling the vehicle: *“Just like with airplanes, the producers should be held accountable for anything related to their products. That is to say, then they should also be credited for the things that works out good.”*

Several respondents however point out that it might not be so simple and that it very much depends on the situation and the accident which also raises an ethical issue.

One respondent says that if the robot makes a mistake, then it should be the company owning the robot's responsibility but if the robot can purposefully be instructed by a human to put another person in a harmful situation, then it is the responsibility of the human giving the instructions. Another respondent explains: *"Obviously it is going to depend on what sorts of mistakes or accidents occur and why they occur. Highly trained humans can make mistakes and unintentionally (or sometimes intentionally) cause accidents. Responsibility assignment can be complex task."* Determining who has the responsibility is quite a difficult question to answer and it might also need regulations or laws to determine. But by having the question of responsibility and ethical dilemmas in mind in the developing phase of a robot, some of the unwanted scenarios can perhaps be avoided by well thought design, programming, and testing of the robot. Therefore, it can be recommended that the developers of the robot ensure that they at an early stage consider ethical, societal, and legal barriers.

## Conclusion

In conclusion, the citizens surveyed in this study had mostly positive perceptions of the robot, RobStruct, when imagining it as a coworker at a construction site. They saw great potential for the robot to help with physically demanding and repetitive tasks, improving the work conditions for construction workers. However, there were some concerns about the robot's functionality and potential to be in the way on the site. The preferred means of communication with the robot varied, with most respondents preferring voice commands or a physical interface. Respondents also suggested that the robot should be able to use multiple modes of communication to navigate safely in the unpredictable and loud environment of a construction site. The citizens believed that it would make sense to work alongside the robot in situations where it can relieve humans of repetitive and physically demanding tasks and/or when it can relieve work to allow them to focus on other tasks. However, there were also concerns raised about the implementation of automation in the construction sector, specifically the lack of well-defined responsibility in case of accidents, errors, and flaws, policy issues and the fear of a digital divide. Overall, it seems that further development and real-life testing of the robot would be necessary to fully realize its potential benefits and address any potential barriers to its use on construction sites.

# consortium

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