THE ACCEPTANCE OF SERVICE ROBOTS:

TOOLS AND STRATEGIES FOR THE SUCCESSFUL DEPLOYMENT IN COMPANIES

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Content

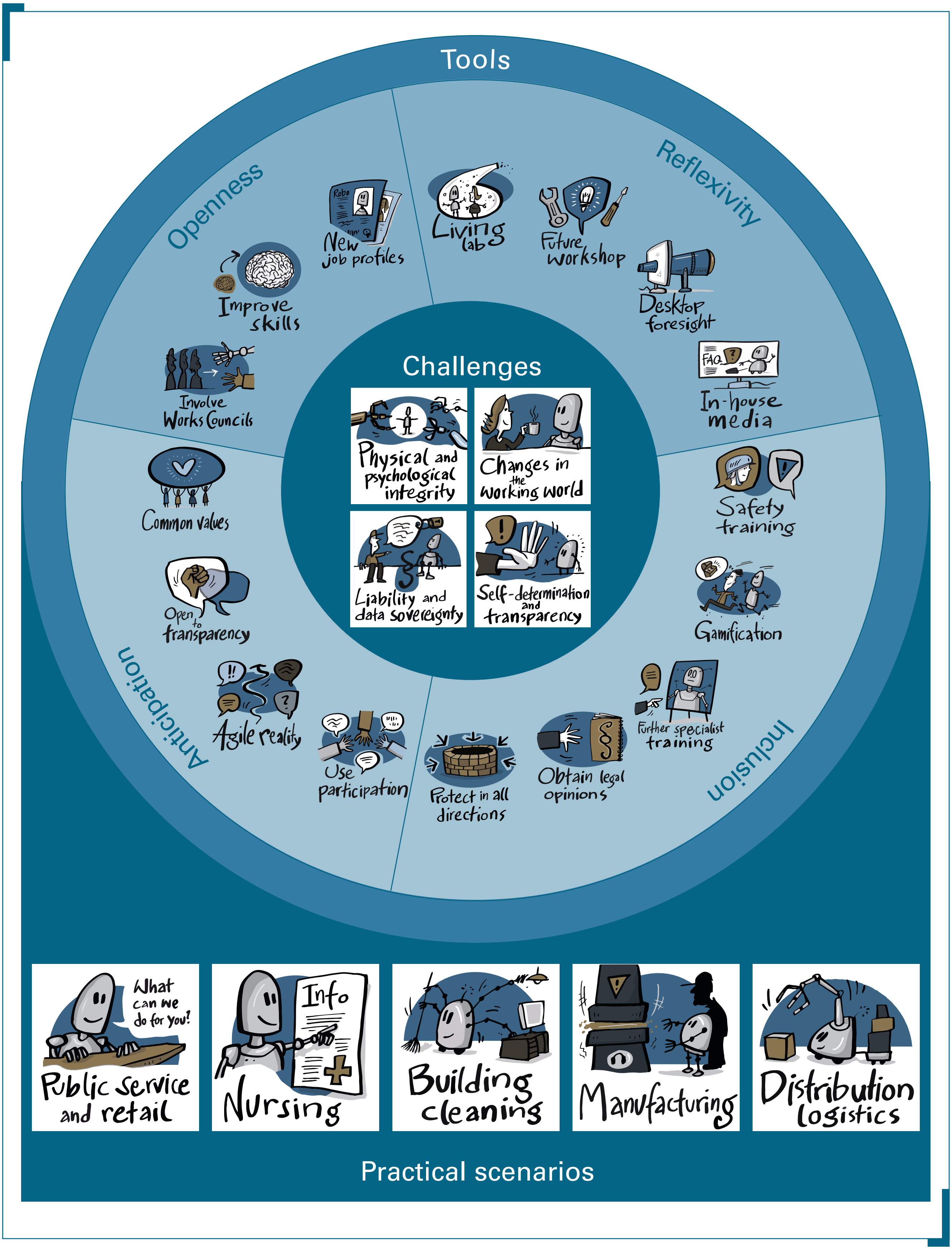
Summary

Robots that closely interact with human beings - commonly known as service robots - are becoming more and more common. This is reflected by current and forecast sales increases in the double-digit percentage range. Technical developments are generating enormous innovation momentum for these applications: Artificial intelligence (AI) provides more autonomy, and new sensor technologies capture their environment in a more intelligent way. These and other cross-sectional technologies are ensuring growing functionality and opening up new fields of application: from logistics and manufacturing to agriculture, medicine and healthcare. However, potential applications for robots in both the professional and private sectors are not determined solely by technical developments. Appropriate cultural, social and industrial conditions also have a key role to play.

Just a few decades ago, industrial robots were usually separated from humans by cages and performed linear operations. Today's service robots, however, act (partially) autonomously and increasingly collaborate with humans in all areas of application. Interactions with human beings at the workplace and the use of robots in households or public places can lead to ethical and social challenges. Such challenges arise wherever the rights or the well-being of individuals who interact with service robots are violated. These challenges have to be tackled and overcome at the right time.

This study addresses people and institutions responsible for the implementation process. It analyzes the most important non-technical challenges with social and ethical implications in terms of physical and psychological integrity, changes in the working world, liability and data sovereignty as well as selfdetermination and transparency. In order to overcome these challenges, a total of 16 tools and strategies are presented which correspond to the four cornerstones of responsible action, i.e. openness, reflexivity, inclusion and anticipation. Based on expert interviews and workshops with people who already use service robots, the challenges and the exemplary use of different tools and strategies are explained in detail in five practical scenarios from the areas of public service and retail, nursing, cleaning, manufacturing and distribution logistics.

The challenges and tools described here, will provide readers with a comprehensive basis for successfully designing the implementation of service robots in their own or their customers' companies from a non-technical perspective.This study was designed as a living document. We would like to invite all readers to share best-practice examples of further tools and strategies or challenges that have not yet been considered by sending an e-mail to: toolbox.robotics@iit-berlin.de.


Tools
Openness
Reflexivity
Anticipation
Inclusion
New job profiles
Living lab
Future workshop
Desktop foresight
In-house media
Improve skills
Involve Works Councils
Challenges
Physical and psychological integrity
Changes in the working world
Liability and data sovereignty
Self-determination and transparency
Safety training
Common values
Gamification
Open to transparency
Further specialist training
Agile reality
Use participation
Protect in all directions
Obtain legal opinions
What can we do for you?
Public service and retail
Info
Nursing
Building cleaning
Manufacturing
Distribution logistics
Practical scenarios

1 Introduction

Robots that closely interact with human beings - commonly known as service robots - are becoming more and more common. Technical developments are generating innovation momentum for these applications: Artificial intelligence (AI) provides more autonomy, and new sensor technologies capture their environment in a more intelligent way. These and other cross-sectional technologies are expanding the range of functionalities and opening up new fields of application.[1] Concepts range from logistics and manufacturing to medicine and nursing. However, potential applications for robots in both the professional and private sectors are not determined solely by technical developments. Adequate cultural, social and industrial conditions also have a key role to play.

1.1 What are service robots and where do we encounter them - today and in the future?

In contrast to conventional industrial robotics, the term service robotics is not self-explanatory. The distinction between the two forms has grown historically. Most of the robots available on the market today are conventional industrial robots[2] which are used in the automotive industry throughout the country, for instance, for welding or painting operations. Industrial robots usually perform very narrowly defined tasks in the manufacturing process: Their range of actions is usually limited to a single process to be carried out under clearly defined surrounding conditions (International Federation of Robotica 2016).

Unlike industrial robots, the International Organization for Standardization (in ISO Standard 8373[3]) defines service robots as all systems for use in environments that are not fully automated. Due to this negative definition, robots are considered service robots whenever they are used in a private/individual or in a business/professional context – i.e. outside fully automated manufacturing lines. Unlike stationary industrial robots installed in a manufacturing process, service robots must be able to operate in constantly changing environments. They must therefore be able to learn, adapt and correct errors autonomously.

The International Federation of Robotics (IFR), the international umbrella organization for robotics, estimates that between 2019 and 2021 around 730,000 service robots will be used worldwide in the industrial sector and around 50 million service robots in the end consumer sector, with sales in the segments totalling around EUR 33 billion and EUR 12 billion, respectively, during the above-mentioned period. IFR expects to see double-digit growth rates over the coming years (see Fig. 1).

1 https://link.springer.com/chapter/10.1007/978-3-662-58042-4_7
2 https://www.vdmashop.de/World-Robotics-122/World-Robotics-2018-Industrial-Robots---PDF-Edition.html
3 https://www.iso.org/standard/55890.html

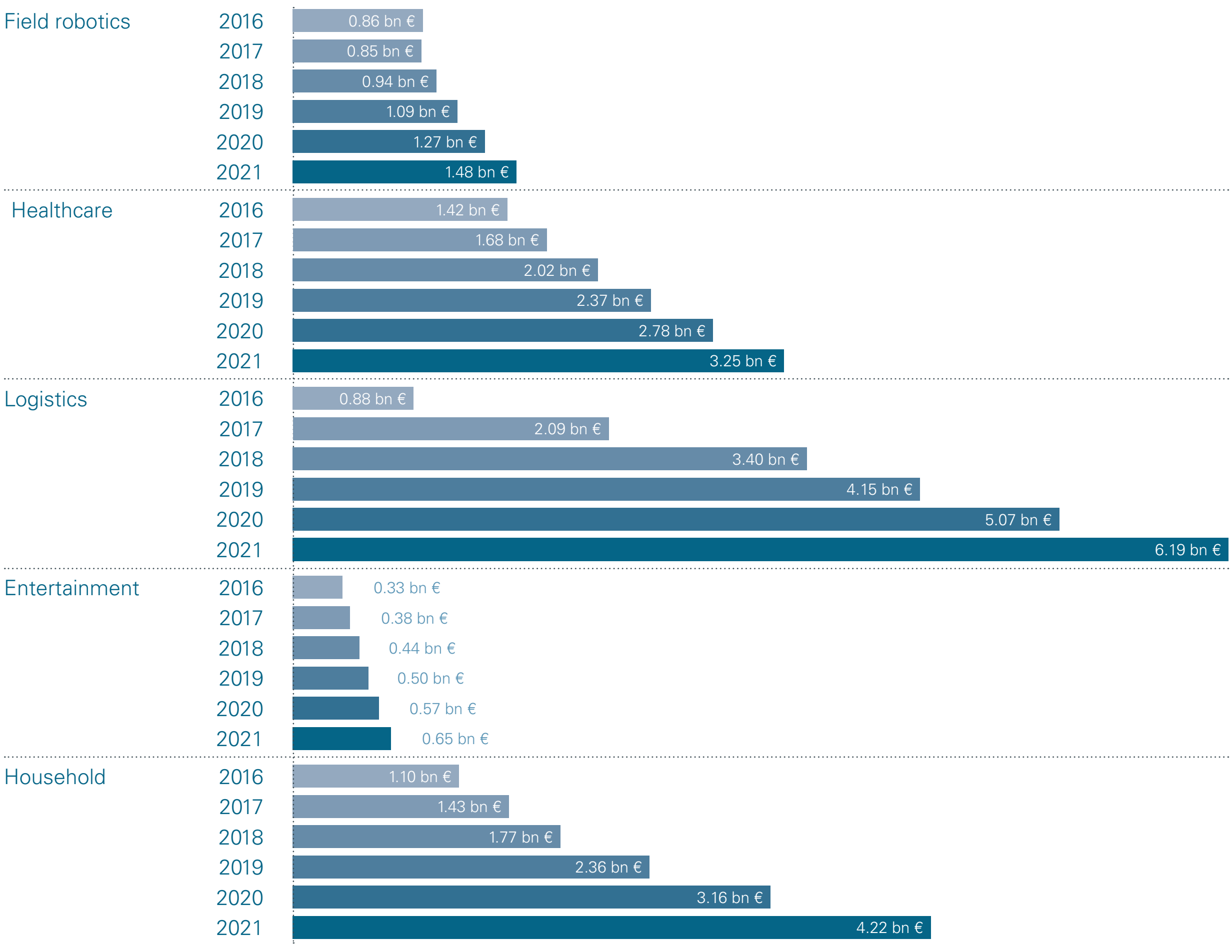


Fig. 1: Market potential in the five top-selling segments of service robotics. Figures for 2018 are preliminary estimates. The sales figures for 2019 to 2021 are based on interpolation of estimated total sales for the three years assuming a constant annual growth rate in the individual segments (own diagram, data from: (International Federation of Robotics 2018)).

These forecasts show that service robots have the potential to become part of the professional and private lives of many people in the future. At present, however, service robots are not yet very common in a professional context. Only very few people have interacted with a robot beyond pilot projects, let alone cooperated with one in their professional lives. The high prevalence of robots predicted by IFR is not yet reflected in the degree of contact people have with robots. The question of whether people in Europe use a robot at home or at work was answered in the negative by 87 percent in 2012 and by 85 percent in 2017 (European Commission 2012; 2017). This shows that, despite technical development leaps, the prevalence of service robots is progressing only slowly compared to other technologies.

1.2 The division of labor and acceptance of robots

A survey on how humans and robots should work on different fields of activities in the future paints an interesting picture (see Fig. 2). In the case of physically strenuous activities, such as those found in manufacturing, but also, for example, in the cleaning or nursing sectors, just 6 percent of those surveyed can imagine this work being carried out in future by humans alone. 70 percent can even imagine these activities being carried out by autonomously acting robots. 24 percent believe in the division of labor between humans and robots. Even stronger co-operation between humans and robots is expected in other areas of activity: When it comes to decision-making, creativity and problem-solving, but also, somewhat surprisingly, to repetitive activities, around half of those surveyed believe in co-operation.

How should humans and robots work on different fields of activity in the future?

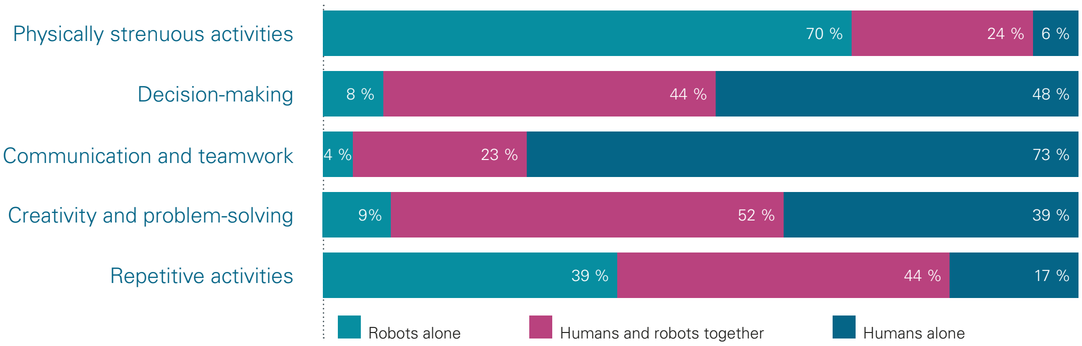


Fig. 2: Survey results on the question of how humans and robots should work on different fields of activity in future (own representation, data: Statista, Fraunhofer IAO, Statista, source: https://de.statista.com/statistik/daten/studie/869849/umfrage/umfrage-zur-zukuenftigen-arbeitsteilung-von-mensch-und-roboter/)

The prevalence of service robots and their successful co-operation with humans will depend heavily on the extent to which they are accepted by the people who are to work with them. A user's acceptance first means whether the potential offered by the service robot is in fact utilized for a given application and depends on various factors. Several studies address the issue of acceptance of service robots. From a psychological and usability perspective, the focus is here on the external attributes of robots. Nitto et al. for example, show that Germans prefer robots that look like machines over human-looking humanoids which are preferred in the US and Japan (Nitto et al. 2017). However, these studies are not very revealing with regard to the acceptance of service robots in work environments where functionality and workload relief by robots are the key issues (Dietsch 2010). Mutlu and Forlizzi, for example, note that acceptance of service robots that support staff in their work varies not only between different organizations, but even among different units within an organization. Their ethnographic study in a hospital suggests that acceptance of a service robot varies depending on different patient profiles, although it is not the patients but staff who interact with the robots (Mutlu and Forlizzi 2008).

While these studies go into detail, representative studies are conducted to identify public attitudes towards robots, but these studies too paint a complex picture. Eurobarometer data from 2012, 2014 and 2017 show different levels of acceptance in different areas with diverging trends among the European population. The acceptance rate among people who would allow robots perform surgical operations on them has increased slightly. However, the rate of robot support decreases when it comes to elderly people requiring nursing care (see Fig. 3). The acceptance of robots in work environments shows an abrupt decline: Whilst the acceptance rate was still as high as 47 percent in 2012 and 2014, it dropped down to 35 percent in 2017.

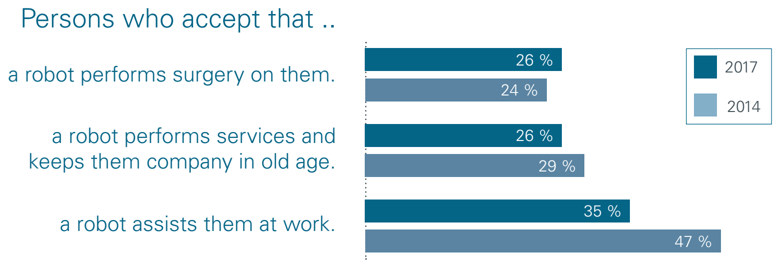


Fig. 3: Acceptance of robots among the European population (diagram, data based on 'Special Eurobarometer 382: Public Attitudes towards Robots" Dataset, available at: https://data.europa.eu/euodp/data/dataset/S1044_77_1_EBS382).

A Forsa survey on robotics shows a different picture. This study directly addressed the issue of acceptance in conjunction with an anticipated improvement in the living conditions of those surveyed. 83 percent of respondents said that they could imagine using a service robot at home if this would allow them to stay in their own four walls for longer in old age (Forsa 2016). The willingness to accept a robot as a care support also depends strongly on the degree of contact intimacy.

It was found that acceptance does not depend solely on technical functionality or external appearance. Instead, the context of use and the cultural background of a society are key influence factors. However, the study also shows that acceptance can fluctuate greatly over time (Meißner and Trübswetter 2018). What is accepted today may be rejected tomorrow or vice versa (Grunwald 2005). Acceptance should therefore also be a factor when it comes to implementing service robots.

The term acceptability refers to what should be accepted when weighing up positive and negative aspects. While the acceptance question sets the design framework for technology to receive positive ratings, acceptability refers to aspects which individuals may consider to be negative and which are outside the individually accepted framework, but which are nevertheless reasonable.

Grunwald points out that every technology entails consequences that are negative for individuals but nevertheless appear legitimate from a societal perspective. One example of this is the waste incineration plant, which nobody wants to have in their backyard, but which is nevertheless necessary to handle the waste volumes generated by society. Analogous conclusions can be transferred, for example, to the future use of robots in nursing. Even if an individual fears the loss of personal contact the use of robots can still be necessary, meaningful and valuable for society in view of demographic change and the increasing shortage of skilled workers.

Against this background, systematization and participatory implementation of the reasonableness and design options of technology users is necessary (Grunwald 2005). Different levels of reasonableness can be identified: Impositions that can be individually controlled, impositions with cumbersome alternative options or impositions without alternative options.

The central aspect of acceptability is that the implementation of technologies is a democratic rather than an individual challenge. The aim is to enable people to evaluate a new technology and its implications and to make decisions which also consider areas beyond their own field of activity.

The picture at large is that the use of service robots has considerable economic and social potential. The task now is to strengthen the two levers of acceptance and acceptability when introducing (individual) service robots. The aim of this study is to identify the specific challenges in achieving acceptance and acceptability, to concretize these challenges on the basis of example scenarios and to identify effective tools that help to master these challenges.

1.3 Methodology and structure of the study

The methodology of the study includes both analytical and participatory elements, each of which served to identify challenges and tools and create a valid empirical basis for the structure and content of the study (see Fig. 4).

Literature analysis: The first step consisted of an empirical and theoretical-conceptual literature analysis. The empirical studies included data on the prevalence and acceptance of service robots. The conceptual literature included sources on the ethical, legal and social challenges of new technologies as well as on methods and concepts of the 'responsible Innovation' approach. The literature served as a basis for a conceptual grid that encompasses the specific challenges as well as the strategies and tools for overcoming these challenges.

Qualitative interviews: The study included ten expert interviews with persons who have successfully implemented service robots at their companies. The selection of these persons was based on an online research and a survey on the robots they use. The interview partners came from different industries and units within companies and were (co-)responsible for the implementation of service robots in their organizations:

- Automotive and vehicle construction (manufacturing and logistics)
- Mechanical engineering (manufacturing)
- Electronics (manufacturing)
- Retail (service)
- Facility management
- Healthcare/Nursing (service)
- Pharmaceutical sector (logistics)
- Public authorities (service)
- Logistics sector

User workshops: The results of the literature analysis and interviews were condensed into a workshop concept. The study included three workshops with service robot users and experts. These experts had scientific know-how in the fields of robotics and responsible innovation. Together with the application partners, it was discussed how ethical and social challenges are reflected in operational practice.

Practical scenarios: During the workshops, several scenarios were presented as a basis for discussion. These scenarios were then validated and condensed on the basis of the participants' practical experience. Challenges as well as strategies and tools were related to the scenarios and as a result of the study supplemented by realistic application examples.

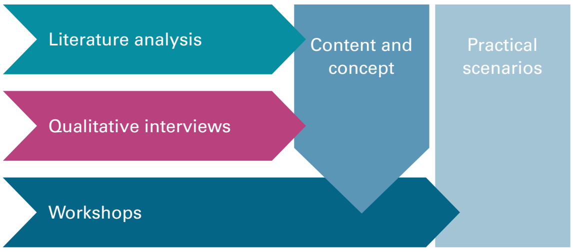


Fig. 4: Methodical structure of the study (own diagram).

In the following, the study will first take a more detailed look at the implementation process in organizations and the business units involved. This will be followed by an outline description of ethical and social challenges. This discussion focuses on 'physical and psychological integrity', 'selfdetermination and transparency', 'changes in the working world' as well as 'liability and data sovereignty'. These topics are relevant for all the applications considered here. They contain the main focus areas of academic and public debates as well as aspects of practical relevance for interviews and workshops with the application partners. In a next step, strategies and tools will be presented which can be used to adequately address these challenges in an operative context. Finally, five example scenarios will be presented which were developed on the basis of the interviews and workshops. The challenges presented up until that point will be addressed in more detail within the scenarios on a case-by-case basis. This will be directly followed by suggestions for the use of specific tools in order to identify ways to overcome challenges.

2 The acceptance of service robots - challenges in operational implementation

The interviews and workshops have shown that the implementation of service robots is already being implemented in different parts of organizations. The value chain according to Porter can be used to illustrate these distributions (Porter 1985).

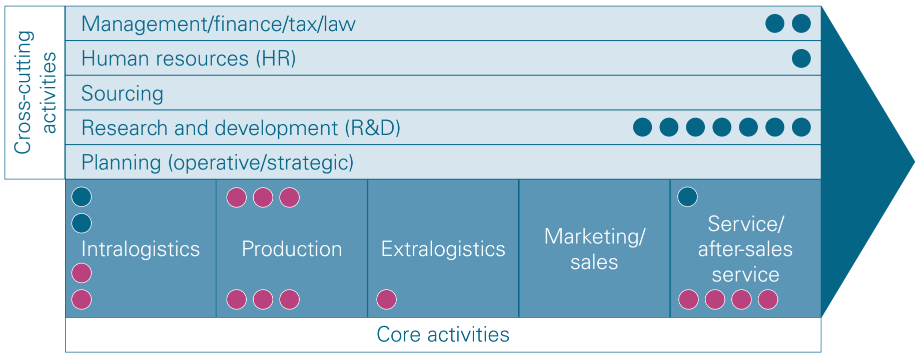


Fig. 5: Value chain according to Porter (Porter and Kramer 2006). Red dots represent areas where service robots were used by the experts and workshop participants interviewed, whilst blue dots are the work areas of the people who initiated or were responsible for implementing the project.

Intralogistics: The main task of robots in intralogistics is order picking. The systems have gripper arms and storage trays and can navigate autonomously in a warehouse. The robots collaborate here with specialists, such as warehouse workers.

Manufacturing: Manufacturing is the core activity within the value chain of industrial fabrication/assembly/production. In the automotive sector, for example, this includes flexible vehicle manufacturing workflows thanks to the use of service robots. For example: In mechanical engineering, a Cobot is used in manufacturing to relieve physical strain on skilled workers. In all the cases surveyed, the companies concerned were striving for technological excellence in their respective sectors. Accordingly, the implementation was also driven by technical development and also carried out in accordance with corporate stratgy.

Extralogistics: Outbound logistics was the application area of one case – in this instance, however, there was a high degree of intervention in the process chain. The service robots were used to deliver goods, if possible, directly to the delivery area, thereby increasing overall manufacturing efficiency. Since the use of the service robots was closely interconnected with operative steps, adequate staff qualification measures were required.

Service/after-sales service: Robots used in service units come into direct contact with an organization's customers or support staff when carrying out services involving customer contact. The fields of application of the interviewed persons included the retail trade, public authorities and logistics companies. One interviewee, who accompanied the implementation of the service robot, worked in the company's HR department, the other interview partners were in charge of operational planning and technical development.

The distribution of service robots (see Fig. 5) shows that, on the one hand, the implementation process cannot be generalized, but instead varies strongly depending on the operational context. On the other hand, the interviews and workshops with the participants also revealed strong similarities between the cases in terms of operational challenges. Against this background, the following challenges are not contextspecific and do not occur at a single organization alone, but reflect operational practice and scientific discourse.

Explanation of 'support activities' in the value chain

Support activities are performed by those parts of an organization whose primary tasks do not belong to the organization's operational core, but instead support and manage manufacturing.

Firm infrastructure: The infrastructure of an organization describes its hierarchical structure and its resources. This is where both the strategic management of a company and certain units, such as the works council, are located.

Human resources management: This function determines how a company manages, recuits and trains its employees.

Technology development: The technical development function comprises business units that drive an organization's technical excellence.

Procurement: These units are responsible for procuring resources for use in manufacturing.

Challenges

Just a few decades ago, industrial robots were still separated from humans by cages and performed linear operations. Today's service robots, however, act (partly) autonomously and increasingly collaborate with humans in all areas of application. Human-robot interaction (HRI) at the workplace, at home or in places of public life can pose ethical or social challenges. These challenges arise wherever the rights or the well-being of individuals who interact with a service robot are violated. Furthermore, the increasing use of service robots can have an impact at a higher social level. If this leads to a deteriorating financial situation for individuals or to a less properous society, for example, this must also considered a challenge that needs to be overcome.

Ethical and social challenges posed by service robots are increasingly addressed in scientific discourse. Expert committees, such as the German Ethics Council, are working on guidelines for political or legislative debates on these technologies. When it comes to human-robot interactions, questions about possible violations of human dignity are at the centre of the discourse. One of the topics related to this discourse is the protection of human self-determination in interactions with service robots. Lawyer and ethicist Julian Nida-Rümelin considers the question regarding the clear assignment of responsibilities to be a key issue. This is because the legal status of (partly) autonomous robots is still unclear, just as much as the question as to whether the manufacturer, the owner or the user is responsible for the actions of a service robot. According to Julian Nida-Rümelin, it is essential that legislation and everyday moral be adapted in a manner that allows their application to new technologies, such as service robots or autonomous vehicles (Hevelke and Nida-Rümelin 2015; Nida-Rümellein 2017). Oliver Bendel, expert of the German Bundestag, sees service robots as a fundamental challenge with regard to informational self-determination and data protection, in areas of interaction between law, liability and responsibility, and also with regard to changes in the working world (Bendel 2016a, 2016b). Robot ethicist Kate Darling identifies similar challenges. She claims that the increasing integration of service robots into our everyday life and workspace will create major social and economic challenges with implications that are as yet unforeseeable. She takes a less critical view than Nida- Rümelin with regard to efforts to develop robots to become increasingly human-like (Darling 2017). All three authors agree that more transparency, better (safety) standards, the work in ethics committees and open normative discourses, are important measures in order to respond to the challenges posed by the use of service robots.

> 'One [...] important strategy in the introduction of human-robot collaboration was to build up in- house integration expertise with the help of external consultants, especially for safety issues. [...] One of the biggest challenges was to compensate for system weaknesses on the part of manufacturers, especially with regard to safety issues.'
>
> Process planners, assembly

Media coverage of confrontation with these challenges and personal experience with service robot interaction influence the acceptance of human robots. In order to meet ethical challenges, solutions in the form of technical design principles are available - a logical consequence of the technical nature of the matter. By applying these principles in product development and system integration, ethical and social problems should be considered and solved. An example of this is IEEE's (Shahriari and Shahriari 2017) guideline 'Ethically Aligned Design for Artificial Intelligence'[4]. VDI's 'Ethical principles of the engineering profession'[5] is a guidance document that is not related to autonomous systems.

In the following, four fields reflecting ethical and social challenges will be presented. This will be followed by a description of tools that help those who are responsible for the implementation process of service robots to adequately address these challenges and thereby strengthen acceptance and/or generate acceptability of service robots within organizations. The tools can be used to make use of the non-technical scope for implementation.

4 https://ethicsinaction.ieee.org/
5 https://m.vdi.de/fileadmin/media/content/hg/16.pdf

'I see the greatest potential for conflict when robots are safety- relevant, and of course everyone jumps up when it comes to safety.'

Works council, manufacturing

2.1 Physical and psychological integrity

The preservation of physical and psychological integrity is a fundamental ethical principle. It is not only in the analysis of literature that we can see that this is a fundamental aspect of machine ethics (World Commission on the Ethics of Scientific Knowledge and Technology 2017)[6]. The interviews and expert workshops also revealed that integrity is a key issue for both employees and employers. Its preservation therefore is a practical precondition for a successful implementation process. It also became clear that safety was a task which all interviewees considered to be important.

Physical integrity: The right to physical integrity is enshrined as a fundamental right in the Basic Law of the Federal Republic of Germany (Art. 2 (2)). Wherever humans interact with (partially) autonomous machines, there is the possibility of endangering the physical integrity of humans, be it at the workplace, at home or when using a service. The cause of such an injury can be attributed to several factors. Causes can be malfunction or improper handling of a robotic assistant or simply a mishap. Safety at the workplace, well-trained specialist personnel and an employee-friendly process organization in human-robot collaboration (HRC), however, are safety-relevant factors in the field of non-technical freedom of design. If these aspects are taken into account during implementation, this creates both a sense of safety and the necessary skills for the safe use of service robots.

Psychological integrity: Several studies have been published on the impact of technologies on psychological health, such as the question as to whether there is a link between the use of smartphones and the psychological state of mind (Owens Viani 2018; Ward et al. 2017). Likewise, scientists have also researched psychological health in the working world in conjunction with human-machine interaction (Robelski 2016). But to what extent can psychological integrity be endangered when interacting with a robot? In some cases, for example, stress can arise due to changes in familiar processes in the working world, for example, when the use of a robot reduces cycle times of work processes. Another example of how service robots can compromise psychological integrity is the fact hat they depend on the acquisition of data as a precondition for interacting with humans. However, many people are very concerned about protecting their privacy and they do not know what this information is used for. For some people, this can trigger a feeling of anxiety and being watched. Furthermore, many people fear that the use of service robots, especially in nursing, could reduce the quality of communication and lead to a loss of emotionality or empathy (Dillmann and Kahl 2017)[7]. Both our interviews and the workshops suggested that this could lead to a growing sense of loneliness and isolation.

6 https://unesdoc.unesco.org/ark:/48223/pf0000253952
7 https://www.aerzteblatt.de/nachrichten/83493/Umfrage-Wenig-Akzeptanz-fuer-Pflegeroboter-und-kuenstliche-Intelligenz

2.2 Self-determination and transparency

The right to self-determination is an important ethical principle in enlightened societies. Just like the right to physical integrity, the right to freedom of action is enshrined as a fundamental right in Article 2.1 of Germany's Basic Law. This topic is discussed as part of the public discourse on ethical, legal and social challenges posed by technologies, be they (service) robotics, artificial intelligence or human enhancement[8] technologies. The protection of self-determination was also a central topic in annual meetings of the German Ethics Council regarding the interaction of humans and service robots (Nida-Rümelin 2017; Boddington 2018; Diettrich 2018).

Experts see the protection of self-determination as a central ethical challenge and voice this opinion in political discourse (Elkmann 2016; Bendel 2016b). The interviews and workshops on which this study is based showed that there are two aspects to the question of self-determination in the everyday life of organizations: Self-determination in the execution of work on the one hand and transparency on the other.

'We saw this with Industry 4.0, where the first union representative referred to Charlie Chaplin's Modern Times. At that time, it was mechanization, now it is digital, in the gear train of digitization.

What are the three topics that arise time and again?

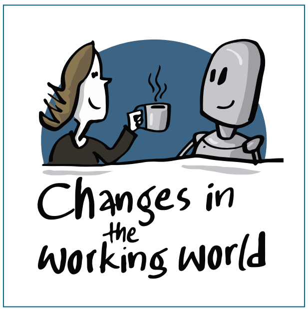
The first is loss of control, the loss of self-determination.'

Henning Kagermann, acatech (Annual Meeting of the German Ethics Council 2017)

Self-determination: If people feel restricted in their decisions or actions, this poses a serious challenge. This becomes particularly clear when it comes to the use of service robots in a professional context, such as manufacturing. If, for example, robotic assistants support workers by providing them with a certain range of tools for a given task, this can create the feeling of a lack of freedom and of being subject to the will of the service robot. Workers with many years of professional experience, in particular, often draw on situational experience. Collaboration with the robot is perceived as a limitation. Besides low acceptance or reservations towards the robot, stress, inattention and injuries could lead to further undesirable consequences. This becomes even clearer when, for example, the cycle time of individual work steps is reduced by a robot, thus creating a feeling of helplessness towards the machine in addition to a feeling of being subject to external control. It goes without saying that this also applies to other areas, such as nursing and retail: Wherever people are supported by service robots, certain choices should be made by people (Kehl and Coenen 2016).

Transparency: The so-called black box problem is taken up in specialist literature and in public debates on artificial intelligence (AI). The term 'black box' describes the lack of transparency and the difficulty in understanding decisions made by AI. This is the result of the high number of arithmetic operations and the amount of data on which a decision is based (Guidotti et al. 2019). The problem also becomes apparent with service robots. If the decision-making process of a service robot appears intransparent, this can mean that it is perceived by people as a black box, i.e. as a dark, incomprehensible system. Due to this lack of transparency, human-robot collaboration lacks one factor that is usually present in the interaction between humans: trust. While we have learned to build an empathic and emotional connection to people and to interpret their gestures and facial expressions, our connection to service robots is different. This can lead to a lack of trust and unnatural behavior. The service robot is perceived as unpredictable or difficult to assess. The resultant feeling of not being in control of the situation, fear of accidents or of the outflow of data recorded in the interaction can inhibit people in their interaction with a service robot or cause them to act in a less self-determined manner. In the health sector, in particular, transparency regarding the fulfilment of functional tasks and human intervention possibilities has an important role to play due to the high degree of sensitivity.

8 The term 'human enhancement technologies' refers to biomedical interventions that are not designed to treat or heal, but to perform beyond natural limitations. These technologies include NBIC technologies (nanotechnology, biotechnology, information technology, cognitive science), ranging from pharmaceuticals to robotic prostheses and brain computer interfaces to gene therapies.



'Fears of impersonal contact with patients and layoffs were also voiced.'

Head of nursing research, hospital

'To me, fear of job loss and of being left behind is a challenge in the introduction of service robots.'

Process manager, manufacturing industry

'A potential of social conflict exists when the depth of intervention (change) is high, when new skills are required (such as programming skills if robots are safety-relevant...)'

Works council member, manufacturing industry

'...younger employees were more open, older employees sceptical or inhibited.'

Employee in process improvement in assembly, manufacturing industry

2.3 Changes in the working world

Changes in the working world are another focus of the debate on the ethical and social challenges posed by service robots. Discourse in the media, academia and politics (Darling 2017) is controversial regarding this topic: Will jobs be lost or new jobs created? The consensus is that the working world will change. One camp sees the introduction of service robots as a consequence of job losses and a disadvantageous change in job profiles. Other perspectives interpret these transformations as opportunities. They take the view that, although the increasing use of service robots will lead to job losses, more new jobs and employment profiles will be created. A ZEW study commissioned by the Federal Ministry of Education and Research confirms this. Although digitization in Germany between 2011 and 2016 led to 1.5 percent more citizens being employed (Arntz et al. 2017), retraining existing workers and training skilled workers in sufficient numbers for the newly created job profiles still remains a challenge for society. Not only technical literature, but also the interviews conducted for this study showed that job cuts and changing job profiles are (Bossmann 2016) relevant challenges with potential for social conflict for both employers and employees.

Loss of jobs: The increasing use of service robots in the service and care sector, in logistics and in industrial environments means that more and more activities that were previously carried out by humans are now automated. During the interviews and workshops, it became clear that many employees who are confronted with the introduction of service robots at their company are concerned about losing their jobs. Fears linked to this are, for example, the loss of financial security or a reduction in the current standard of living. The loss of jobs due to the introduction of service robots is a central problem for some employees. This fear gives rise to reservations and creates obstacles for their acceptance. The solution to this problem is one of the central tasks when it comes to designing the implementation process in a responsible way.[9]

Change in job profiles: With advancing automation and the increasing use of service robots, many activities previously performed by humans will become tasks for robots (Hilgendorf 2016).

The interviews and workshops revealed different ways to perceive this challenge. From the point of view of many employers, finding a solution to the shortage of skilled workers and sufficiently skilled personnel for the tasks of the future is a central challenge. In this context, some of those surveyed also reported a perceived digital divide that will have to be addressed when introducing service robots. While younger employees are more open to the introduction of robotic assistance systems, older employees often express reservations or doubt as to whether they will be able to acquire the necessary skills to use such systems in a competent way. The reservations among employees are based on the need for further qualification measures or changes in processes that have been tried and tested for many years. On the other hand, younger workers often consider changes in requirements to be positive and opportunities for further development. Furthermore, the elimination of strenuous physical and monotonous work is seen as a gain, especially in the field of distribution logistics and manufacturing. In areas with demanding skills requirements (such as industrial mechanics or nursing), however, sceptics suspect that a service robot will lead to a loss in the quality of work results.

9 https://www.bundestag.de/blob/428792/.../a-drs-18-24-104-data.pdf

2.4 Liability and data sovereignty

Questions of law, in particular, liability and data sovereignty, are closely related to the transparency of decisions made by robots. Service robotics is still a young, rapidly changing and constantly growing field. The number of stakeholders and preconditions to be met is often higher than expected at first glance in situations that are to be judged from a legal point of view. Besides the humans interacting with a service robot, such as an employee, robotics manufacturers, system integrators, software developers or platform operators are also involved in the operation of a robot and may be jointly responsible for a malfunction that causes damage. In addition to liability for damage to property or personal injury, data protection issues must also be reassessed (in particular, as a result of the EU General Data Protection Regulation (GDPR) which has been in force since May 2018) (Müller 2014; Japanisch-Deutsches Zentrum Berlin 2011).

'In some areas of application there are still no clear legal positions or precedents. One should think through all possible scenarios and consider which areas of the law are affected.'

Vice President of Robotic and Innovation, Logistics

Liability law: Legal experts are currently still discussing whether existing legal bases can be applied directly to (partly) autonomous service robots. In view of technological change, some authors see a need to further develop existing regulations and to adapt existing law to the new circumstances.

In this context, law professor Susanne Beck is doubtful whether the current legal framework can adequately reflect the new constellations that are emerging in the field of human-machine interactions. Law practitioners are often faced with the difficulty of proving a clear causality between misconduct giving rise to liability and damage. Proof of misconduct by a given participant is difficult to provide, not least in view of the large number of different parties involved in the manufacturing of a service robot. Due to the division of labor between robotics manufacturers, producers of individual parts, software developers and platform operators, it is hardly possible to establish clear responsibility of an individual party. Furthermore, service robots often have to be 'trained' for a specific task. The user who trains or educates a machine in a certain sense thus also has a considerable influence on how a service robot can make decisions. 'It is therefore almost impossible in many cases to identify the precise fault in a concrete decision.' (Japanisch-Deutsches Zentrum Berlin 2011)

Another challenge is the use of a robotic assistance system where the user makes the final decision. It is possible that the machine initially worked incorrectly and is therefore the real root cause of an accident, for example. In this case too, it is difficult to unambiguously decide who or what is responsible. From a legal point of view, is not yet finally clear how such uncertainties are to be dealt with in the future. Experts believe that legal challenges will also increase as the autonomy of machines increases. The resulting legal uncertainty leads to an uncertainty that employers deciding to introduce a new service robotics solution are eager to avoid. An uncertain legal situation can also significantly impair the acceptance of a service robot. Special attention is paid to cases where service robots interact with untrained personnel in public spaces as well as in the service and healthcare sectors. But even for professional users of service robots who are supported by them, an unclear legal situation can pose a risk that leads to reservations or rejection (Japanisch-Deutsches Zentrum Berlin 2011; Müller 2014).

Data protection law: Wherever robots are used and interact in a (partly) autonomous manner with humans, data is processed and (in some cases) stored. A large number of the service robots used today can only perform the intended tasks after training for this specific action in the respective environment on the basis of large data sets. As a general rule, the more complex the task, the more data is required. In some cases, data collected in real-life operations is used as a basis for improving a system further. In interaction with customers or employees, data about persons is collected, processed and often stored (Müller 2014). The question of the legality of processing personal data has gained new relevance after the GDPR came into force. Personal data may only be processed with the consent of the data subject or subject to authorization in any other form. In the context of employment relationships, obtaining the employee's consent typically involves certain problems. On the one hand, the employee who interacts with the robot can revoke his consent at any time. On the other hand, all employees without exception must give their consent. Although it will generally be possible to have recourse to a statutory provision permitting the processing of personal data, the permissibility of processing is nevertheless linked to sector-specific regulations on employee data protection, which may also require the involvement of the works council. Moreover, data protection issues can arise where health data is to be processed (for example, in nursing care). The processing of health data is subject to specific conditions under the GDPR, and this will probably lead to greater legal uncertainty (Haustein 2016).

3 Strategies and Tools

How can challenges in the practical implementation of service robots be adequately addressed? Which activities can be used to proactively shape challenges? This chapter presents a number of strategies and tools which can be used to organise the non-technical aspects of the implementation of service robots in different phases. While the strategies represent the framework conditions or principles (reflectivity, anticipation, openness and inclusion), the tools are activities that can be implemented into practice. There is neither a one-to-one match of challenges and tools nor is there a definite sequence of activities over time. Instead, the different tools can be applied to several sub-aspects of the challenges, or they can be used in a variable manner in practical life, depending on the given problem.

3.1 Design options in the implementation process

The manner in which ethical and social challenges are met varies both in terms of the application context (or industry) and the timing within the implementation process. A central challenge for using tools is the Collingridge dilemma, which means that at an early stage of development, the design possibilities are high, but little is known about the technology, whilst at a later stage, the design possibilities are low, but a lot is known about the technology and its implications.

The scientific examination of this dilemma has a long tradition. Since the 1980s, approaches such as Technology Assessment (TA), Responsible Research and Innovation (RRI) or Ethical, Legal and Social Implications (ELSI) have been developed in order to integrate methods from social science and humanities into technology development (Schomberg 2013a; Stilgoe et al. 2013). The focus of these approaches is to anticipate ethical and social aspects already at the research stage and in this way to facilitate the future transfer from research to product development.

As part of these discourses, extensive methods have been developed which are primarily based on social science practices. They include, in particular, the integration of user perspectives and the anticipation of social side effects which the introduction of a new technology would entail. These methods include qualitative interviews, quantitative questionnaires, laboratory tests in which users test technologies, as well as focus groups and observations in application contexts.

While these methods are scientifically sound and proven as well as generic by nature, in that they can be applied to varying contexts, they are only conditionally suitable for the implementation process because their reference to the operational context is only abstract. This diagnosis itself is not new: The development of RRI methods for application in an industrial context has since 2016 been the subject of the EU's PRISMA research project[10] which aims to promote the connectivity of RRI methods primarily in the sectors of synthetic biology and nanotechnology (van de Poel et al. 2017). Such systematic, practice-orientated approaches have until today not been made in the field of service robotics.

10 http://www.rri-prisma.eu/

The interviews and workshops concretized this requirement: If a technology does not already have a specific functionality, operational framework conditions are not adapted either. This ultimately means that an organization does not effectively change framework conditions based on hypotheses.

The reports in the interviews showed that those responsible for implementation first had to know and evaluate the functionalities and features of the service robots before they could even communicate with other departments or future users. The Collingridge dilemma mentioned above is therefore different when it comes to implementation: Although the operational context can only be changed to a very limited extent at an early stage, smooth use of the service robot must be possible at a later stage. This means that the middle phase of the implementation process must be used for design tasks (see Fig. 6).

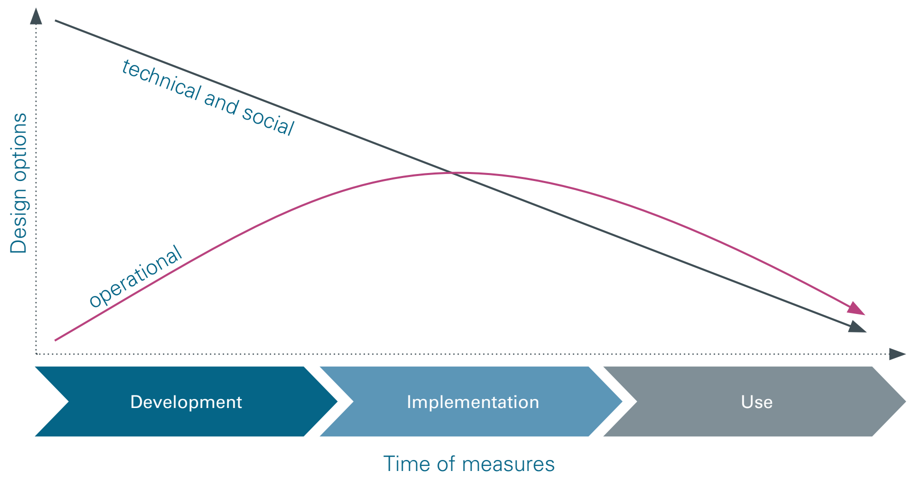


Fig. 6: Design options as a function of time. The blue line represents the conceptually ideal process, whilst the red line represents the operational reality as it emerged from the interviews and workshops (own diagram).

The strategies and tools described below are set up against this background. They can be implemented during different phases, but can also vary over time. Similarly, some tools are based on strategies without being tied to each other.

3.2 Reflexivity or 'holding the mirror up to oneself'

Reflexivity is an attitude towards one's own actions and the starting point for responsible innovation. It involves being aware of the limitations of one's own knowledge and implicit preoccupations. The aim of the toolbox is to recognize implicit assumptions and view the 'service robot' innovation from different perspectives and to use these.

The introduction of service robots is often less motivated by faulty processes than by the need to keep pace with competitors. These motivations, however, remain implicit for a long time, even though they could actually be communicated as an incentive. Questions arise such as: What does the company stand for? Is it all about maximizing profits? Or are values such as 'good work' also part of the corporate culture?

Reflexivity is not limited to reflection, but can be put into practice. Implementation can, for example, begin by mapping all persons affected by the introduction of the robot. Addressing these persons is initially time-consuming since the topic can be perceived from very different angles. However, the effort will pay off during the course of implementation, and the participation of the works council and the human resources department can also help to meet these challenges.

What were the main objectives of the implementation?

'Our manufacturing actually went well. The implementation of robots was strongly driven by the fact that we didn't want to lag behind our competitors.'

Technical developer, medium-sized company

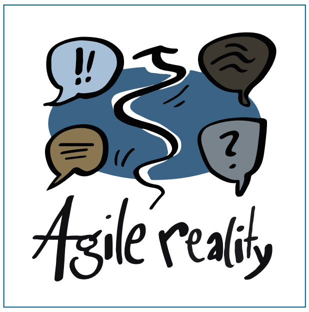
'It goes without saying that the 'robots' issue is linked to changes at the company. One wonders, of course: What do we stand for, where are we going?'

Works council member, large corporation

'I was surprised to see how many colleagues were directly or indirectly involved in the use of robots.'

Technical planner in manufacturing, large corporation

The 'Agile reality' tool



The implementation of service robots is new territory for most companies. A number of challenges, such as finding the perfect balance between control and autonomy in working with service robots, cannot be precisely determined prior to implementation. Instead, initial practical experience with robots must be used as feedback for strategic planning and requirements must be adapted.

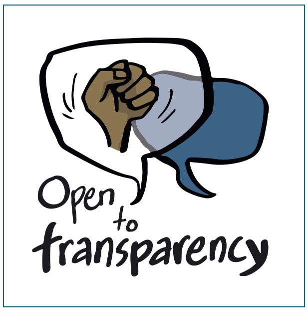
Agile planning makes it possible to anticipate challenges and to proactively develop solutions taking the operational application context into consideration at every step of the way. This means that implementation must be based on iterative feedback loops rather than the waterfall model.

Example: Agile methods originating from software development methods are increasingly used in project management as well. The 'SCRUM' method is one example. This means that a project is carried out in sprints, in which partial aspects are processed and then documented in a backlog. This allows individual steps to be promptly analyzed by the team and strategies and requirements can be adapted.

Advantage: With agile project management, requirements that only emerge during the implementation phase can be considered and fulfilled. This reduces friction losses and allows reality- based implementation.

Disadvantage: Agile project management requires training for individual employees, thereby tying up resources. However, the methods acquired are not limited to the context of service robotics, but can be applied in a variety of other areas.

> **TIP!**
> 'What is good work?' Common values, the importance of good work and creative scope can be discussed in a workshop with participants from different business units. It is important to identify implicit standards of good work. These implicit values should also determine the requirements for co-operation between service robots and humans.



The 'Open to transparency' tool

An open error culture in the organization enables a pragmatic approach to challenges. Decisions that are transparent are easier to comprehend and therefore have more legitimacy vis-à-vis the operational units of the organization. Service robotics, in particular, benefits from an open error culture because the implementation of service robots is currently a novelty at most companies and errors should have a learning effect. At the same time, the courage to be transparent also implies openness towards recorded data that is generated when robots are used in practice and allows conclusions to be drawn with regard to practical work.

Example: Service robots are often implemented in application-orientated research projects, such as the German economics ministry's funding programme PAiCE. The application partners are required to communicate the development status and possible implementation scenarios in a transparent manner to their staff, so that neither fears nor exaggerated hopes are triggered with regard to service robots.

Advantage: Transparency makes processes and decisions comprehensible and increases their acceptance by third parties. The disclosure of collected data also addresses the increasing demand for the responsible handling of personal data.

Disadvantage: This reveals not only achievements and successes, but also failures and mistakes. It is part of an organization's error culture to learn from failure.

> **TIP!**
> The individual steps of the implementation can be continuously documented in a 'living document'. This makes decisions transparent and traceable.

The 'Use participation' tool

The participation of stakeholders makes it possible to counteract 'blind spots'. Participation means more effort at the beginning of an implementation process, but this will pay off later because the stakeholders are given opportunities to shape the process and new technology is brought closer to real practice. The implementation of service robotics is susceptible to blind spots, such as the need to master the challenge to maintain psychological integrity or the need for self-determination at work. These issues can drastically impair the effectiveness of service robots in practice and can only be prevented by early participation (Trübswetter 2018).

Example: The 'Orthetic-bionic assistance system' (ORTAS) project developed a smart orthosis to support manufacturing work in the automotive sector. The workforce was involved at an early stage, so that it was possible to identify the challenge of working under high time pressure. As a result, development work focused on the rapid removal and donning of the orthosis. The product became a success on the market after the end of the subsidy period. (Source: https://www.technik-zum-menschenbringen.de/projekte/ortas)

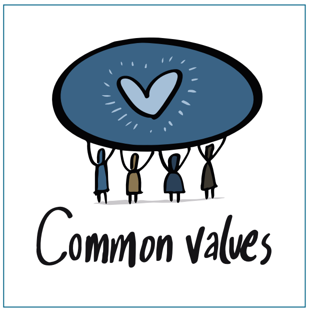
Advantage: Participation makes it possible to identify the issues that shape everyday working life. Service robots can unfold their full potential if co-operation is orientated towards humans.

Disadvantage: Participation is time-consuming. Interviewees reported that participation reaches its limits when confronted with strict work plans and binding supplies. However, participation does not necessarily mean that a full-day workshop is held with all employees. Instead, interest can be expressed in advance and the topic can be discussed during short meetings.

TIP!

As a first step, map all the stakeholders who will be affected by the robot. The value chain (see Fig. 5) can be used for this purpose: This mapping exercise is broken down into strategy/management, technical development, human resources and purchasing as well as operative units (logistics, manufacturing, service, etc.).

The 'Common values' tool



The values of an organization are not necessarily limited to profit maximization, but usually also include professional and social aspects. Common values support implementation because they can legitimize the use of robots.

Example: Companies and associations often have a code of conduct. The Association of German Engineers e. V. (VDI) has issued 'Ethical principles of the engineering profession' (Verein Deutscher Ingenieure e. V. 2002) and the Institute of Electrical and Electronics Engineers (IEEE) as its umbrella organization has issued a Code of Conduct (Shahriari and Shahriari 2017). These and other codes can provide orientation for an organization's own practice.

Advantage: The advantage of a common canon of values is its long-term perspective. Values are not always re-negotiated, but form a common backdrop for the interpersonal relationships within an organization.

Disadvantage: In view of social and technological change processes, values can appear to be outdated. It is beneficial for a company to give space to fundamental questions from time to time and encourage discussion.

What were the greatest challenges?

'For the trainees, it is of course relevant which technology they work with. They always want to use the latest tools and gadgets.'

Technical planner in manufacturing, medium-sized company

'It goes without saying that the shortage of skilled workers is an issue for us. That was the case even before we had robots. But robots are one way to respond to this issue.'

Managing director, medium-sized company

3.3 Anticipating technological and social trends

Implementing new technologies in a responsible way means that one should be bold enough to look ahead and beyond one's own field of activity. Foresight should not be limited to economic aspects, but should also take technological and social trends into account. This involves both analyzing one's own decisions in the larger context and also asking the 'What if ...?' question.

Technological and social trends often clash in business practice. Investments in key technologies, such as service robots, are relevant not only as a way to ensure technological excellence, but also to make sure that trainees come into contact with new technologies and develop appropriate skills. One trend which is of particular concern for organizations and which becomes relevant when service robots are implemented is the shortage of skilled labor. This puts pressure on companies having to deal with new technologies, especially in rural areas. For skilled workers themselves, however, demographic and regional developments also mean that the working world and its requirements are changing and that professional profiles need to be developed further.

The 'Desktop foresight' tool

By conducting desktop researches, technological and social trends beyond one's own operational context can be taken into account. The aim is to generate background knowledge that can be used to focus on challenges such as changes in the working world. Desktop foresight is a starting point for further activities. Topics can be identified which, for example, can be related to operational practice in a future workshop: 'How do service robots change work in general – and at our company?'

Example: The International Federation of Robotics (IFF) offers studies and statistics on service robotics. Its publications include reports on the prevalence of service robots as well as case studies on specific use cases. The publications provide an insight into the versatility of possible applications and the extent to which operational manufacturing processes and requirements for the workforce are changing.

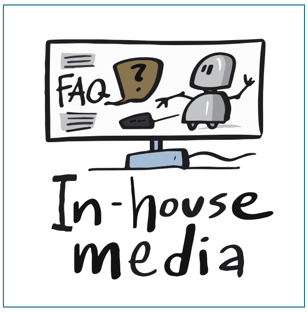
Advantage: Desktop research provides information about service robots without the need to use operational resources (except for working hours). They can also illustrate the scope of the topic by looking at service robots in the context of social trends, such as demographic change or the shortage of skilled labor.

Disadvantage: Desktop foresight is a tool that does not establish a link to the operational context of the implementation and real-world working practices. It leads to implementation processes being conceptually initiated against a background that is abstract for many employees.

TIP!
Use public data and studies for desktop foresight. Platforms offering up-to-date data on the subject of robotics include, for example, the following:

- EU Open Data Portal (https://data.europa.eu/euodp/data/)
- Federal Statistical Office (Statistisches Bundesamt) (https://www.destatis.de)
- Statista (costs may apply) (https://de.statista.com/)
- IFR studies (costs may apply) (https://ifr.org/)

The 'In-house media' tool



The concept of the implementation of service robots can be initiated through articles (or similar means) in in-house media. Depending on the specific medium, short news, for example, about a robotics innovation, or a dedicated article on the potential and challenges of service robots, can be published. It is important that the topic of service robotics is related to the operational context of an organization. Another example of an article could relate to the topic of data sovereignty to the business context.

Example: An angle for an article could be: 'Service robots as a trend: What does this mean for our organization?' This article can relate desktop foresight results to the operational context, for example, by showing what changes will take place in the working world and how they will affect the sector in which the organization operates.

Advantage: In-house media can be used to communicate topics within the organization in order to initiate a dialogue. This signals that discourse on the topic is taking place and that the implementation of service robots is not a shortterm decision.

Disadvantage: An article alone has only a minor impact if no further activities follow. Contributions can quickly become pipe dreams that are met with rejection.

TIP!
Before publishing, plan a lowthreshold activity which you announce with the article.

The 'Future workshop' tool

Experts and skilled workers meet in a 'future workshop' and jointly develop future scenarios. The experts contribute their knowledge about technological trends, whilst the skilled workers incorporate their hand-on knowledge of real working practice. Formats which can be used include the 'innovation playbook' as a means of developing common ideas about innovation projects, or 'rapid prototyping' in order to give concepts a tangible and playful form. Participants will have the opportunity to draw on their practical experience and learn about service robots, enabling them to discuss challenges, such as autonomy and selfdetermination, in an application-orientated manner.

Example: A 'visual roadmap' puts new technologies, social conditions and the personal wishes of participants into relation with each other on a flipchart. These relationships result in paths that can serve as guiding principles for the implementation of service robots.

Advantage: A future workshop is a format that enables articipation at an early stage of the implementation process. Employees are familiarized with a new technology as well as with operational conditions and are given the opportunity to express their requirements.

Disadvantage: The open format of the future workshop can promise design options for participants that cannot be fulfilled afterwards.

> **TIP!**
> You can find suggestions on how to design a future workshop, for example, at the Robert Jungk Library for Future Issues: https://jungkbibliothek. org/zukunftswerkstaetten

The 'Living lab' tool

In a living lab, a demonstrator is set up in a realistic environment. This offers the opportunity to simulate the use of robots and enter into a dialogue with future users. The implementation of service robots benefits from a living lab, especially through the physical presence of the robot. In this way, challenges, such as physical integrity and self-determination, become more tangible and can be met more effectively.

Example I: In the 'Living Lab Service Robotics' of the FZI Research Center for Information Technology in Karlsruhe, stakeholders from academia and industry as well as users can meet and participate in research on new robotic solutions.

Example II: The 'Living LaB' of the city of Ludwigsburg is a platform where politics, administration, industry, science and citizens meet. New technical solutions, services and business models are tested directly as pilot projects and then developed to market maturity, including a successful service robot deployment project.

Advantage: Living labs make new technologies tangible before they are implemented in everyday working practice. Playful experience can break down prejudices and create new momentum.

Disadvantage: Living labs are complex, expensive and dependent upon the availability of a new technology. Using established research facilities is less expensive than operating an in-house living lab.

> **TIP!**
> There are permanent and temporary living labs. Organizations with no living lab of their own can get in touch with an established lab in their region. The 'living labs' map of InnoLabs provides some suggestions:
> https://www.innolab-livinglabs.de/de/living-labs-landkarte.html

The 'Obtain legal opinions' tool

Obtaining a legal opinion can create additional security. Experts at law firms that specialize, for example, in occupational health and safety law can help to identify legal challenges at an early stage and make the implementation legally secure. In liability cases, this offers the additional security of being able to rely on the expert opinion. Law experts can also objectively examine situations with regard to personal data that is collected during the interactions with a service robot and they can offer their advice on GDPR-compliant implementation of a service robot.

Example: A law firm is retained within the scope of the implementation project. Three experts jointly evaluate the situation from a liability law perspective and assess the handling and storage of process data. They prepare an expert opinion which provides precise information on the law-compliant design of the human-robot collaboration and on how the data generated in the interaction with the robot is stored in accordance with the GDPR. Since at least one software manufacturer, one system integrator and one company specialising in application-related interface design are involved in addition to the company that sells the service robot, a legal opinion provides information on the liability shares of the respective parties in the event of damage to property and personal injury.

Advantage: A legal opinion not only gives companies a high degree of security with regard to liability issues. Transparent use and communication of such an expert opinion also shows the employees they are legally protected.

Disadvantage: The professional evaluation of scenarios where service robots are used is timeconsuming and costly. Since service robotics is a new field, the number of precedents is so far limited. Some questions are currently being dealt with in legal discourse. Nevertheless, investments in legal certainty are often sustainable and pay off in the long term.

TIP!
Search for law firms and consultants who specialize in technical or data protection law. They can support you with legal expertise during implementation.

How did the implementation process go at your organization?

'It went really well after two young employees developed a taste for it and accompanied the implementation process. They also raised the acceptance rate among our colleagues because everyone noticed that we were not going to leave them alone.'

Works council member, large corporation

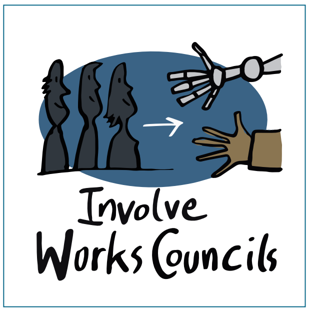
'Service robots usually perform relatively simple tasks. We then created new job profiles in which it became clear that the transfer of activities to robots would enhance one's own role.'

Planner in logistics, large corporation

3.4 Openness to solutions

The implementation of service robots in operational practice is often different than in planning: Challenges only arise when you meet them. Similarly, solutions should be based on real practice rather than on a 'one-size-fits-all' approach. This does not mean that there is no plan for implementation, but that enough free capacity is provided in the plan to be able to respond and take advantage of changes, challenges and opportunities.

During the implementation of service robots, a general openness to service robots pays off. This may include, for example, that it is no longer necessary to obtain expert knowledge from external providers, but that this knowledge is now generated internally, based on the interests and informal expertise of the employees. These resources, which are hidden in everyday life, must be identified and fostered through internal co-operation. Existing bodies, such as works councils, should be involved in order to generate design ideas.



The 'Involve works councils' tool

The introduction of robots at larger corporations is usually accompanied by the works council. The Works Constitution Act (BetrVG) provides for this in sections 90 and 91. However, this involvement should not be of a 'signing-off' natue, but should allow a certain freedom of design. The works council as the body representing employee interests can actively use its function as a link. Concerns, reservations and claims can be identified and discussed with employees. The works council can help to develop participative elements and further specialist training formats.

Example: The works council analyzes changes in workplaces, processes and environments. These demands are reflected in the employees' everyday activities. They are then used in order to define requirements for co-operation with robotic assistants. The works council organises further specialist training courses and communicates the design requirements of human-robot collaboration to management.

Advantage: Involving the works council creates transparency and creates more participation opportunities, thereby strengthening acceptance. Furthermore, the works council has a trust function and can communicate concerns from the shopfloor to management while ensuring anonymity.

Disadvantage: Works councils do not always have the capacity and competence to implement farreaching participative formats. In many cases, however, works councils maintain good contacts with trade unions, such as IG Metall[11], and can ask for support for planned training and further specialist training measures.

TIP!
Works councils have facilities and hold coordinated regular meetings which can be used for a joint workshop.

The 'Improve skills' tool

Implicit knowledge is often available in the form of employee skills that can be used to shape the implementation of service robots. These skills are often of an informal nature and represent interests or self-taught skills of employees which must be identified and supported.

Example: After the employees have been informed about the plan to introduce service robots, a survey is carried out. Employees who are interested in the new technology and the design of human-robot collaboration are able to take measures to increase their competences, so that they can play an active role in and participate during the implementation process. Two employees will be able to take part in a specialist training course in order to become specialists for human-robot collaboration in their field of work. The know-how gained can be incorporated into the process of planning and implementing service robotics. Pre-existing experience in the operative business is used to optimally shape human-robot collaboration and to overcome obstacles in process planning.

11 The IG Metall is an important metalworkers union in Germany. URL [https://www.igmetall.de/ueber-uns/ig-metall--a-strong-community].

Advantage: The integration and further training of interested parties expands existing practical knowledge in the operative business by adding important know-how about human-robot collaboration. The newly qualified colleagues serve as an anchor of trust for the rest of the workforce. A new link is created between employees and management.

Disadvantage: Further further specialist training and training cost money and often also mean temporary non-availability of manpower. However, the long-term increase in value by far exceeds the temporary losses and helps to keep the organization on an innovative track.

TIP!
A workshop gives employees the opportunity to contribute their creativity. Employees who demonstrate a special degree of commitment can be appointed as champions and given the opportunity to accompany the implementation as such. This approach can be continued in 'train-the-trainer' measures, so that the basis for the transfer of skills is already laid down during the implementation phase. The transfer of general digital skills, which go beyond the operation of the service robot, can strengthen acceptability of this and other future technologies.

The 'New job profiles' tool

Service robots can change operational activities. This is also accompanied by changes in job profiles which can be perceived as a loss or as an upgrading of one's own role.

Example: During the course of the implementation process, new job profiles are assigned to employees who have attended further specialist training programmes. As experts, they develop from workers to operators who know how to handle and maintain robots. When new personnel is recruited, employees with expertise in human-robot collaboration are specifically in demand.

Advantage: New job profiles make it possible for the introduction of a service robot to be perceived as an incentive for career development. Moreover, they enhance the way the organization is perceived on the labor market. Companies that have, for example, integrated the job profile of operator or specialist for human-robot collaboration into their infrastructures are often perceived as more innovative. At the same time, a clear description of new roles promotes the company's organization and smooth process planning.

Disadvantage: Restructuring is initially associated with costs and time expenditure which must be managed. The successful definition of new roles at a company not only requires theoretical skills, all units of the company must be integrated, from workers to human resources departments and management.

TIP!
New job profiles do not have to be limited to human employees, but can also contain a 'robot' job profile.

What further specialist training measures were offered?

'Our employees were trained not only in operation, but also directly in programming, so that we can directly implement changes in the processes.'

Technical planner in manufacturing, large corporation

'Unfortunately, the usability of service robots is not yet so mature that we were able to omit training.'

Process planner in logistics, large corporation

3.5 Including all stakeholders

Participation should accompany the implementation of service robots during all phases. Whilst participation yields primarily formative benefits during the initial and planning phases, it serves to address all those who deal with service robots in their everyday lives at subsequent stages. Inclusion of all stakeholders should promote the acceptability of service robots through further training and support of learning in everyday life.

In the later phase of implementation, the area of application of service robots is defined and only changes within narrow limits. It is now also clear which skills are necessary to deal with service robots in everyday life. The further specialist training of employees should not only cover the formal communication of safety-relevant aspects, but also impart orientation knowledge that can be used to assess the relevance and sustainability of service robots. Further qualification measures do not always call for completely new formats; instead, existing offerings can be supplemented with specific content. The integration of service robots into everyday work environments can, for example, be supported by gamification approaches, such as a 'service robot rally'.

The 'Safety training' tool

Inclusion must impart formal, safety-relevant knowledge. Responsibility here means ensuring the physical integrity of employees. A precondition for processreliable human-robot collaboration is to have fundamental knowledge of how to operate a robot, its possibilities and limits, possible sources of danger and correct behavior in the event of unexpected damage to property and personal injury. For this reason, manufacturers often offer safety training courses for all persons involved in human-robot collaboration. Furthermore, special training courses are offered for occupational health and safety officers which help to take into account challenges to physical integrity as well as conformity with safety-relevant norms and standards, such as EN ISO 10218 or ISO/TS 15066 to the necessary extent.

Example: Employees responsible for operational safety attend seminars in order to refresh their knowledge of safety aspects and guidelines relevant for human-robot collaboration. In the operative area, persons interacting with the robot are trained by qualified personnel. In process planning, standards and norms are adopted in order to ensure operational safety, and their implementation is taken into account in the planning of the implementation process.

Advantage: Security training and advanced training courses can anticipate and implement safety-relevant aspects to minimize hazards for employees. A sense of operational safety in the interaction with robots contributes to them becoming more accepted. Conflicts are avoided during inspections, for example, by the employers' liability insurance association.

Disadvantage: Safety training can be time-consuming. Operational processes must be designed in such a way that there is no loss of productivity.

TIP!

Make use of training opportunities in order to train employees in charge of operational safety. They can pass on their newly acquired knowledge to their colleagues at internal events.

TIP!
The area of operational safety not only includes accident prevention, but also the ergonomic design of the human-robot collaboration.

The 'Gamification' tool

Playful elements can support the communication of contexts and operating methods and hence make it easier to address employees with different educational backgrounds. This principle is applied in the interface design, but can also be transferred to the physical environment of the service robot.

Example: Employees are familiarized with the interaction with the new robotic colleague in a playful way. An interactive or gamified learning tutorial is used during the induction phase for interaction with the service robot. In line with the tutorial videos, tasks with changing difficulty levels are integrated. As with computer games, employees can climb a level or collect points that reflect their learning success in an abstract way.

Advantage: Employees are playfully introduced to human-robot collaboration. This not only increases acceptance, but also the motivation to deal with new technologies through a reward system. Furthermore, employees with a slower learning curve feel more comfortable in an environment where they are not observed by human instructors.

Disadvantage: Employees with greater technical interest and people who use information and communication technology more intensively in their private lives are often more open to gamification measures.

TIP!
In a service robot rally, employees navigate through various operational stations where they have to solve simple tasks using the robot. Only when all employees have solved all tasks together will they receive the 'treasure'.

TIP!
Get in touch with organizations and agencies that develop gamification concepts for professional contexts and can help you to implement them.

The 'Further specialist training' tool

Further training of employees is usually part of implementation processes: The employees must be trained to use the new technology. However, training courses do not have to be limited to teaching operating knowledge, but can also contain orientation knowledge regarding the implications of new technologies, such as service robots.

Example: Keynotes and inspirational talks are held as part of a one-day event where employees are familiarized with all facets of the future of work. Following informative programme items, workshops are held where participants can discuss the opportunities and challenges of the changing world of work together with experts and develop visions for their workplace and the employer.

Advantage: Training measures help to generate acceptability by ensuring that employees do not view the topic of service robotics from the perspective of their practical work alone. The implementation of HRC solutions can thus also be communicated as an opportunity in larger contexts.

Disadvantage: Company training days are intended to arouse curiosity. The challenge for organisers and coordinators is not only to design an exciting programme, but also its adequate didactic implementation.

TIP!
Company training days: Further specialist training courses in service robotics do not have to be stand-alone courses, but can be combined with other topics, such as 'service robots in the context of the shortage of skilled labor' within the framework of training days.

TIP!
Academy: Training employees does not have to be limited to application knowledge, but can additionally include conceptual aspects. In academies, topics such as 'planning work processes with service robots' can be addressed and developed to transferable approaches.

The 'Protect in all directions' tool

Insurance companies have also come to understand that the use of service robots creates a large number of challenges for organizations and their employees. Policies are already available that are tailored to service robot applications. Insurance can create confidence and a sense of reassurance not only to the owners of a service robot, but also to the workers who use it.

Example: When implementing a robot, the manufacturer points out that specific insurance policies are available. Contacts are established between the buyer and a specialist insurance company. The buyer decides to take out liability insurance, electronics insurance as well as cyber protection insurance.

Advantage: Insurance not only strengthens the confidence of employees, but also reassures companies. In addition to a legal opinion, they can also take out additional liability insurance.

Disadvantage: Insurance for service robots can be expensive depending on the application.

TIP!

Robot manufacturers know the critical aspects of different application scenarios of their products. They can optimally advise the purchaser of a robot as to which policies are important.

4 Applying the tools: Five practice scenarios

In order to generate a thorough understanding and enable the use of the toolbox in a hands-on manner, we will present five example scenarios with different areas of application of service robots in the following, with scenario-related and challenge-specific examples of the application of the tools. The description of the tool applications will be supported by further recommendations which are integrated by the icons in white boxes and reflect which tools are particularly suitable to adequately address ethical and social challenges in a certain area of application of service robots.

A service robot is used as an assistant in a shop or public office. Customers can contact the robot and ask for help finding a product. Citizens can say what they need and are guided accordingly to a clerk who will inform them about the respective responsibilities or forms that may be required. The service robot includes a display on which, for example, product information or comparisons can be displayed. In this scenario, the service robot performs an assistance function and relieves employees of simple everyday tasks. This gives them more time to respond in a service-orientated manner to complex requests and inquiries from customers or citizens.

The challenge

Challenges in the sense of violating physical integrity are important in this example scenario because the service robot here interacts not only with trained personnel, but also with citizens. Accidents can occur due to malfunction, programming errors, as well as improper maintenance. Customers, however, cannot be trained in the use of robots.

Psychological integrity can also be affected in this scenario. Especially older people, who have little confidence in new technologies or who have problems using them (they may, for instance, not be able to use a touchpad as an interface between humans and robots), may feel lost in the digital world. This is equally valid for customers and employees. This form of digital divide must be overcome by a suitable design of the implementation process.

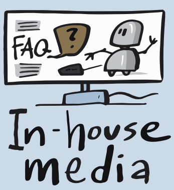
The tool

By supporting employees in the acquisition of safety-related skills, the employer can counteract a possible threat to physical integrity. A safety training course is conducted as an in-house seminar by a representative of the robot manufacturer and an employee responsible for occupational safety. The seminar serves to familiarize the employees with the basic functions of the robot, behavior in the event of malfunction and the redesign of the shop area. The theoretical part is followed by the employees testing all the functionalities together. Behavior in case of malfunction is also exercised. Finally, everyone puts themselves in the position of customers and can be supported by the sales assistant in the search for goods.

The challenge

When interacting with a service robot in a shop, people with little confidence in or understanding of technology may feel uncomfortable and react negatively. The employees too should develop confidence in the service robot. Instinctive rejection based on the strangeness of the robot can become a problem. Individual responses to customer wishes are a crucial feature in this case. One interviewee reported that he considered the implementation to be a failure because expectations regarding the robot's flexibility were very high. Employees and customers assumed that the robot had at least the same potential to respond to inquiries as comparable voice-controlled assistant systems for home use (Alexa, Cortana or Siri). The lack of flexibility meant that people felt restricted rather than supported.

The tool



Employees feel less secure when a robot autonomously navigates through the shop and interacts with customers. Before being used, the robot is trained to work in the new environment which is additionally redesigned to facilitate the robot. Internal company media are used to prepare the workforce for cooperation with the service robot. The robot is treated like an employee and is given its own e-mail account. It regularly communicates with its future team, describing its basic functions, its learning success in the shop and its fellow robots in other branches. It also informs about its possibilities and technical limits. In this way, expectations regarding its functions are not too high, and the employees do not feel restricted later on. The robot introduces itself as a supporting member of the team and places its integration into the team into a larger context.

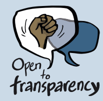
The challenge

Challenges with regard to the changing working world begin with the training of employees who should be familiar with the basic functions of their new service robot. The feeling of not being in control in the event of a malfunction can have a negative impact on acceptance. Employees must be able to skilfully operate the service robot.

The shortage of skilled labor is also being felt in the retail sector. A sales or consulting assistant should make the employees' work easier so that they can perform all tasks a service robot cannot handle. Nevertheless, there is fear of losing one's job, and it is important to counter this.

The tool

Within the framework of an academy, information about the new robot is communicated by the management together with experts. The implementation of the service robot will also be placed in a larger context at such an event. The support for employees by noticeably reducing their workload as well as topics, such as demographic change, are addressed by the experts.



The challenge

When service robots interact with untrained laypersons in the public space, the complicated legal situation caused by the novelty and nature of autonomous systems can become even more challenging. If, for example, people without proven prior knowledge and experience are dependent on interaction with a service robot, responsibilities can shift in the event of damage. Employees and customers must be legally protected against all possible risks. In communications between the service robot and the customer, data is recorded, processed and in some cases stored. In this context, the issue of data protection becomes relevant. The interviews showed that both customers and employees expressed concerns about what would happen to the data generated during human-robot interaction.

The tool

With the decision to use a service robot as a sales assistant, a debate breaks out among the workforce. Just a few months ago, employees were informed about changing conditions with regard to the handling of their data, but also about new demands concerning the handling of customer data. The protection of personal data and the issue of data sovereignty were strengthened with the entry into force of the EU General Data Protection Regulation. Scepticism about what is happening with the data comes to light. Through research in relevant online portals and in publications, management can inform itself about the topics of service robotics and data protection. The essential aspects of the topic are summarised in fact sheets.

A service robot is used in a hospital. It offers support by providing patients with preparatory information prior to MRI examinations. In this application, the robot provides information about the examination process, how patients should behave during the examination, the risks and side effects of contrast media, and possible use of the examination results.

The challenge

Malfunction is the central danger in this case too. In the case of non-compliant patient behavior because, for example, they were not correctly informed about the removal of metal jewellery before an MRI examination, this can have devastating consequences. In the medical and care sector, people who interact with service robots are often frail or impaired. The highest safety standards are therefore required.

Nursing staff have voiced concerns that the introduction of service robots will affect the quality of work. This could be due to an anticipated loss of the particularly important interpersonal, i.e. empathic, contact in the care sector. If this is lost, patients may feel less valued. Co-operation with the service robot must be planned in such a way that this form of patient contact is not lost.

The tool

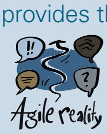
Shortly after the introduction of the service robot, nursing staff agree: Even with simple radiological examinations, non-compliant behavior or insufficient information can lead to injuries. The process owner sees this scepticism and addresses it. The process owner is not familiar with the details of the workflows in radiology and hence needs the specialist knowledge of his staff in order to optimally integrate the service robot at the ward. Injuries can only be avoided through practice-orientated integration. Radiologists and nursing staff are asked whether they want to contribute their experience towards the implementation process. Patients are also asked how they feel when interacting with the assistant and whether they have any suggestions for improvement.

The challenge

In nursing, it is important to respond to the individual patient's needs in a flexible and sensitive manner. In this scenario, very simple tasks are performed by a robot. From a self-determination perspective, an implementation can be considered to be successful if the patient feels respected and not externally determined by the use of the robot. When preparing for an examination with a service robot, any feeling of coercion or helplessness must be avoided for the patient. Nursing staff should maintain the level of flexibility they had prior to implementation, or ideally gain new capacity. If this is not guaranteed due to an excessively restricted range of functions or high maintenance requirements of the robot, the selfdetermination of nursing staff will be limited. The same applies to the patients.

The tool

A living lab is held in order to address the high quality and safety requirements resulting from the implementation of service robots in the health sector. A click demonstrator of the service robot is set up that performs rudimentary functions and plays first information videos to the patients. Nursing staff quickly understand that the service robot provides them with more time and that they can use the newly gained capacity in order to respond more specifically to patient needs.

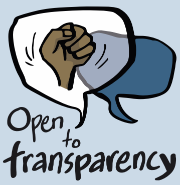


The challenge

There is a clear shortage of skilled nursing staff. At the same time, demographic change leads to increasing demand for these highly qualified experts. Service robots can be used to perform less demanding tasks in clinical and geriatric areas.

If nursing staff are confronted with the introduction of service robots, one important concern may be the risk of losing their jobs. Furthermore, impaired quality of care work (loss of flexibility, intimacy and empathy) is an anticipated side effect that leads to a reduction in acceptance. These concerns need to be addressed.

The tool



Especially in view of an already high workload, management believes that it is impossible to release employees for one or more days for events, such as an academy or training days. It is therefore decided to create more transparency, and a living document is created. This not only documents the individual steps of the implementation process and the robot's learning success. This format informs employees how the challenges due to demographic change and the lack of skilled labor are addressed by business management. The document gives staff the opportunity to understand the socio-economic reasons for introducing the service robot.

The challenge

In the area of health care, special legal requirements apply, also for machines used in this area. The use of service robots brings new technologies into the context of nursing staff and patients, which can mean a higher accident risk than before. Even in the case of a robot that acts as a consulting assistant, all possible scenarios must be identified in advance. Responsibilities must be clear and, at best, defined in contracts. Nursing staff who are supported by a robot must be assured that they will not be legally prosecuted if they did not sufficiently inform patients in person should damage occur afterwards due to a robot malfunction.

Data used in nursing and care environments is considered to be sensitive. Special requirements apply to patient data. Regardless of whether service robots interact independently with patients or whether they support nursing staff – for example, as assistants during a bed change – data from human-robot interaction in the healthcare sector requires special protection. Incorrect or inadequate technical implementation may constitute a violation of a person's data sovereignty. Ensuring data sovereignty and properly communicating the relevant framework conditions, rights and obligations are key challenges. Information in the run-up to implementation is critical for its success.

The tool

When nursing staff are informed that plans exist to use a service robot as an assistance system for patient information, doubts arise with regard to data protection and responsibility for personal injury. Management retains the services of a law firm. Specialist lawyers jointly evaluate the application case and prepare a legal opinion. The opinion assesses the scenario from the perspective of data protection regulations, criminal law and medical law. By obtaining the legal opinion, the implementation can be designed with greater legal certainty, the doubts of the workforce can be taken into account, and in addition, n the event of liability, reference can be made to the opinion.

An autonomously moving vehicle with a gripper navigates through a warehouse. It drives to the components to be picked in accordance with its orders, loads them and takes them to the processing station, to the place of processing in the manufacturing chain or to a new storage location. This application case covers many typical tasks of a warehouse worker. The service robot is designed to safely pick components from shelves without dropping or knocking them over, to navigate freely between workers through the warehouse, and to deliver components to the appropriate stations in the manufacturing chain.

The challenge

Malfunction or inadequate maintenance of the robot may result in physical injury. A changed working environment and negligent workers are additional causes of possible accidents.

If the autonomous picking system is used to transport components to a manufacturing station, an increase in the target workload could lead to stress. This, in turn, can lead to inattention and, consequently, injuries or, in equally serious cases, psychological burdens due to overload. The effect of the service robot would thus be the opposite to what it was used for, i.e. to relieve the strain on employees.

The tool

When the workforce learns of the planned use of the service robot, questions arise with regard to occupational safety. Two workers with a high interest in technical topics and a safety officer are sent to a further training course. Both workers are trained to become specialists for human-robot collaboration and in further topics, such as maintenance and operation as well as occupational safety and the safety of collaborative robots in industrial applications. They can contribute their knowledge thus acquired to the implementation process and become trusted persons for the colleagues in their organizational unit. Scepticism due to fear of injury is countered by bringing expert knowledge to the implementation process, but also in a bottom-up approach by competent contact persons in operative business.

The challenge

A robot used in manufacturing could deliver components faster than workers are able to process them. The increasing speed of work can lead to stress and accidents, but also to a lower level of perception of the limitation in the exercise of the profession. This affects the acceptance of the service robot. Wherever service robots collaborate with humans in processes, care must be taken to ensure that humans retain as much freedom of choice as possible and that there is an option for the final decision, especially with regard to the avoidance of accidents.

The tool

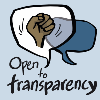
Together with the manufacturer, an interactive tutorial was made available to the employees, which in animated films not only provides operating instructions but also basic information on how the robot works. A robot rally with the service robot was held as part of a company event. The employees brought components from the warehouse hand in hand with the autonomous picking trolley to sections of the manufacturing line for further processing. In this way, the employees are taught in a playful way that the employees in manufacturing still determine the speed of the manufacturing process.

The challenge

Here, employees regard the loss of their own job as a challenge to be taken seriously. The introduction of autonomous order pickers has significantly changed the demands placed on workers. If previously necessary qualifications, such as the ability to drive an order picker, were required, factories and logistics centres of the future will require operators, i.e. skilled workers trained in the handling and maintenance of service robots. There is a need for new skills in the area of in-house logistics. Especially employees who are already older or who have no technical skills according to their selfassessment tend to express scepticism towards robotised support in order picking.

The tool

The discussion about job cuts and new skills requirements among employees was initiated by company management and the works council. The topics are addressed within the framework of the annual in-house training days. The purpose of the event is to inform the workforce on training programmes. Through workshops and presentations, topics such as the future of work in Industry 4.0 will be made accessible to all with support by experts. This not only enables employees to learn about the reasons for introducing service robots from many different angles, but also to explain these reasons by putting them in a larger context. At the same time, the presentation of the training programmes offered gives employees the opportunity to understand increasing automation as an opportunity, for example, when a warehouse worker can acquire additional operator skills.

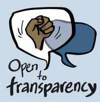


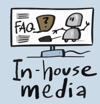
The challenge

Complex service robots like the one in this example require a large amount of visual data. The black box problem with regard to the further processing of this data is a central issue here. What happens to this data? What else happens to the transaction data? Employees can still be afraid that the robot will not recognize them correctly in a complex situation and that an accident will occur. That's why security and a clear legal situation are so important. Employees who are supported by robots in complex and safety-relevant work environments should feel protected against contingencies.

The tool

The management wants to address questions concerning liability and data protection and retains the services of a law firm in order to prepare a legal opinion. The legal experts assess the situation from the perspective of all relevant legal areas, from data protection to criminal law. They prepare the legal opinion. This also gives the company assurance that it can take recourse against the experts in the event of damage for which an employee is held liable, but which was assessed differently in the legal opinion. The central messages from the expert opinion are prepared in a document by the company's legal department together with the works council. The document is presented to employees via internal communication channels. The 'legal opinion' tool is thereby combined with the 'open to transparency' and 'in-house media' tools.





A mobile robot platform for cleaning buildings which is able to equip itself with different modules (such as a vacuum cleaner, wiper or gripper) at a station for specific tasks navigates through a department store. The service robot cleans the shop area, the warehouse, the offices and the sanitary area. Waste is collected in containers and only needs to be removed by the workers in charge. Locations that are inaccessible for the robot, excessively complex objects or unidentifiable contamination are localised and communicated to human cleaning workers.

The challenge

In building cleaning, simple operations can be performed entirety by service robots. The cleaners only have to support the service robot in inaccessible working environments and complex activities. In this example too, workers can be injured in accidents with the robot. If cleaning workers are not properly trained to use of machine, this poses a risk. In conjunction with the feeling of being replaceable, the psychological integrity of workers may be adversely affected. The fear of being overtaxed by co-operation with the robot can cause similar feelings and have a negative impact on the acceptance of the service robot.

The tool

Particularly in the cleaning sector, the sources of danger are often underestimated, as work is carried out with substances that are hazardous to health or irritating. In order to ensure smooth implementation, company management decides to train permanent cleaning staff to become skilled workers for human-robot collaboration for building cleaning. Training will not only reduce risks and generate acceptance, but will also address safety concerns for a wider range of customers using commercial cleaning services.

The challenge

Changes in processes can lead to a feeling of loss of self-determination. If the tasks of employees are limited to areas where the service robot cannot perform the cleaning job, a feeling of being subordinate to the robot can arise. Self-determination at the workplace is limited by the performance range of the service robot. One possible consequence is a decline in acceptance. Scepticism towards the service robot can also occur if employees have little confidence in the technology and can even be increased by the black-box phenomenon.

The tool

Company management responds to scepticism among the workforce and uses service robots only in a few properties on a trial basis. Workers involved in these activities are regularly surveyed about their perception of this cooperation. This gives them the opportunity to make suggestions for the design of human-robot collaboration. In this way, employees in the process planning department receive important feedback which they can take into account during the implementation phase. A joint workshop will be additionally held as a milestone event. This serves to bring together demands on human-robot collaboration from the point of view of employees in operations, management, human resources, the works council, and process planning.

The challenge

One challenge in the building cleaning sector is the loss of jobs through the use of service robots. These jobs rarely require high-level qualifications. Unskilled temporary workers are often employed. It is expected that a large part of this work can be performed by service robots. At the same time, cleaning companies must also fill positions with profiles that include commissioning, programming, maintaining and servicing service robots. If there is a lack of information, property managers and cleaning workers can discover a challenge with regard to skills in dealing with the new assistant.

The tool

Especially older, permanently employed skilled workers express reservations towards their colleagues. They do consider themselves to be able to operate, service and maintain service robots. Furthermore, there are doubts regarding a threatening job loss. Work in operative business is often far from the reality of everyday work. Employees with many years of experience know the difficult tasks of everyday business. These employees must be involved in the further development of cleaning robots. A playbook is created together with the employees. On the basis of their experience, concepts can be developed regarding the tasks which a service robot can perform in their job profile, which challenges have to be considered and how they imagine the job profile of the human cleaning specialist of the future. Together with a graphic recorder, a robotics developer and a customer, scenarios from everyday practice are sketched and further developed on flipchart walls.

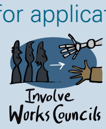
The challenge

When, for example, a service robot cleans an office that also contains personal items, data is generated and usually also recorded. The processing, storage and protection of this data represents a challenge in conjunction with the GDPR if, for example, data on the soiling status of an office is stored in such a way that conclusions can be drawn about the employees working there.

The legal framework becomes all the more important when, for example, a robot is used to clean shops or areas of public life. In the event of damage to property or personal injury, questions of public, criminal and civil law must be clearly answerable. For property managers who have service robots in their area of responsibility, clear rules must exist for handing liability issues because otherwise they would hardly want to take responsibility for use.

The tool

The property managers are happy about the relief, but at the same time express strong reservations: What happens in the event of damage to property and who is held liable in this case? Is it the property managers who are responsible for the smooth functioning of the robot? Property managers voice doubts. What happens in the event of damage? Management recognized this challenge early enough and took out insurance against all possible scenarios. As part of further training programmes for applicationspecific HRC specialists, this management decision is communicated in a transparent manner. Those responsible are introduced to the basic conditions of the policy taken out and are thereby reassured.



Assistance robots in manufacturing, so-called cobots, have already reached a technologically high level of development today and are used at companies. A collaborating robot gripper is used in the manufacturing of a medium-sized supplier company. This robot automatically places workpieces into a CNC milling machine and removes them after machining. The worker, who previously performed these actions himself, carries out quality control at the end of the process and supervises the process.

The challenge

A risk of injury can result especially from negligence or malfunction of the service robot. If sensors that stop the gripper arm in time do not work, there is a risk that a worker may be injured*. Cobots are often used in manufacturing in order to handle increasing batch sizes. Even if an employee is usually physically relieved by a service robot, stress symptoms can occur if the work steps are clocked too quickly. This can have a negative impact on the worker's psychological state and level of attention. Possible consequences are rejection and accidents.

* However, the use of service robots with appropriate safety test certificates can significantly minimize this risk.

The tool

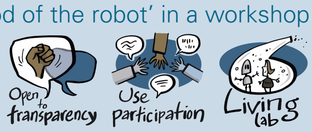
The workforce fears that they will not be able to master the new productivity requirements based on interaction with the service robot. In order to overcome concerns of overload and stress, company management decides to build a demonstrator where employees can practice their work steps with the robot. This quickly shows that the robot has a more supportive function, that it will ease burdens and that workers will retain a high degree of process control. There will be no stress or overburdening. A further added value of the living lab is that, during the trial period, employees can also contribute suggestions for improvement to the implementation process.

The challenge

In the scenario described here, the workers are to be relieved by the service robot. However, if the robot works at a speed that is too fast for the worker, this can lead to reduced acceptance. This type of challenge becomes even clearer when the scenario is slightly modified. Instead of feeding components into a CNC milling machine, the cobot is used to provide tools for specific work steps. If work processes change as a result of this or if certain options are no longer available to workers, there is a risk that they feel restricted when it comes to options or flexibility in the performance of their work. Such a change in work processes can lead to reservations or even rejection.

The tool

The living lab can counteract the lack of acceptance resulting from anticipated stress caused by overburdening as a result of human-robot collaboration. This makes it possible for employees to experience the future of work design hands-on. The expectations arising from the living lab can be met and implemented through an agile design of the implementation process. It is, for example, possible over a period of one month, to ask employees to work on the demonstrator twice a week for half an hour and then to complete a short feedback questionnaire. The results will be evaluated after the 'probationary period of the robot' in a workshop with employees from operative business. Important design requirements can be implemented during the course of the implementation process.



The challenge

Here, too, employees may have doubts as to whether they will continue to be needed and whether they are sufficiently skilled for the increasing interaction between humans and robots. Particularly seasoned employees who have been tried and tested in processes for many years can perceive the collaboration as a disruptive factor. Familiar processes must be redesigned, adding another factor to operations that needs to be considered.

The tool

Open communication and the practical demonstration of corporate values can help to alleviate fears of job loss or stress due to overburdening. The strategic orientation towards the company's own codes, which in addition to economic interest also include the sustainable development of the company, employee satisfaction, family friendliness, personnel development and maintaining competitiveness through a strong innovation strategy, can not only strengthen confidence in the introduction of service robots, but also open up a perspective from which this is seen as an opportunity.

The challenge

In manufacturing, an unmanageable legal situation can be the reason why workers are reluctant to accept the service robot. If defects or manufacturing errors occur in the interaction with a service robot, employees must be aware of who is liable. These concerns become more important when the robot helps to manufacture products that are subject to certain material requirements for safety reasons (for instance, welds). Material defects can lead to accidents and injure third parties.

The tool

Company management is looking for precedents and example scenarios that shed light on the legally relevant factors of human-robot collaboration. Searching for information material, workshop reports, further specialist training offers and presentations from science and industry can be just as effective as contacting the manufacturer. A simple and transparent preparation of relevant aspects of the legal situation for the workforce and the works council strengthens confidence in the decision to use service robots.

5 Outlook

Innovation does not only mean technical optimization, but also an appropriate design of the operational framework conditions. In this short study, the non-technical design possibilities of the operational implementation of service robots have been explained as practically as possible. While literature on this topic remains largely theoretical, the interviews and workshops conducted showed that ethics and social issues can take on very practical forms in everyday business life. Topics, such as integrity, self-determination or changes in the working world, are not abstract and unrealistic. Instead, they already have a significant role to play for users today when they decide to implement service robots in work processes and want to fully exploit their potential. The tools that can be used to master these challenges have therefore already passed their practical test: Many organizations are proactive in dealing with ethical and societal issues and have already implemented a wide range of activities.

The study also shows that ethical and social challenges surface in interaction with the business context, but that there are also cross-cutting issues which reemerge in all industries. The challenges and tools outlined here do not only apply to the scenarios developed within the scope of this study, they can be transferred to other application areas of service robots and of course to other technologies too.

The challenges and tools described here in more detail provide guidance for readers who do not have a technical background and who intend to successfully implement service robots in their own organizations. This study is not intended to be absolutely complete. It is deliberately designed as a living document. All readers are therefore invited to share best-practice examples of further tools and strategies or challenges that have not yet been considered by sending an e-mail to: toolbox.robotics@iit-berlin.de.

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