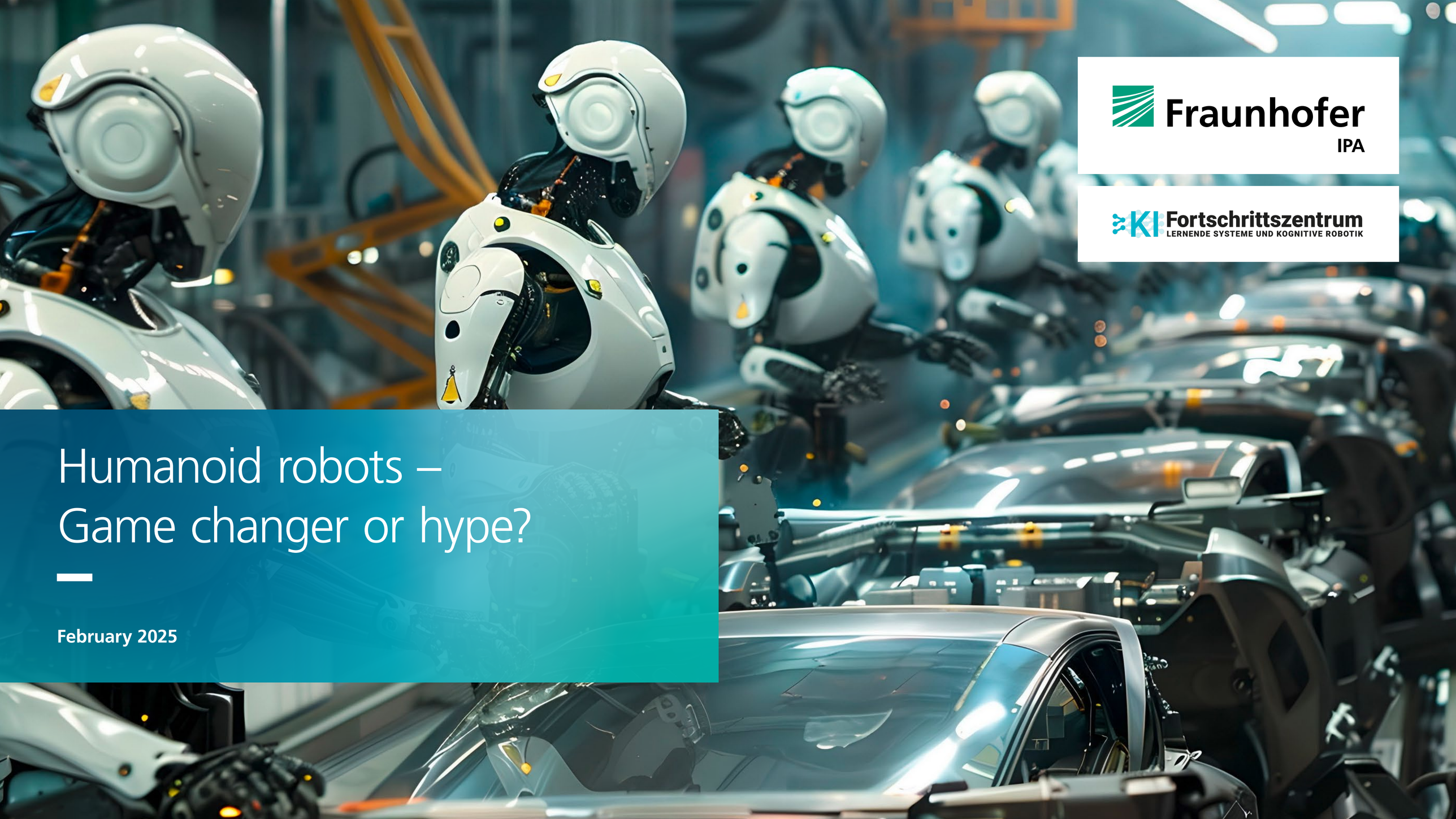

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KI Fortschrittszentrum LERNENDE SYSTEME UND KOGNITIVE ROBOTIK

Humanoid robots – Game changer or hype?

February 2025

Table of contents

Key figures for the study

Active in all sectors

55%

System integrators and component manufacturers

113

Answers

Of which 24 from interviews and 89 from an online survey

45%

Potential end users

Approx. **75%**

Automotive and mechanical and plant engineering

Other sectors

25% SMEs

75% large companies

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Introduction

Introduction

Humanoid robots have dominated the tech news in recent months.

This is confirmed by reports from various large companies that are evaluating the use of humanoid robots. Humanoid robots were also one of the main topics at this year's CES (Consumer Electronics Show). At the same time, the number of manufacturers of humanoid robots is growing rapidly, particularly in Asia.

Impressive, but sometimes manipulated videos of humanoid robots executing transportation or household tasks, as well as manufacturers' statements about possible unit prices of 20–50k USD are fueling expectations that humanoid robots are on the verge of a breakthrough. At the same time, some sources estimate an exponential market growth to 13.25 bn USD in 2029 or 100 bn USD in 2035.

Advocates of humanoid robots argue:
Only a general-purpose robot that can perform many tasks justifies the high costs of development and acquisition. Our environment is optimized for the human body. Thus, a general-purpose robot must be based on the human body and its motion mechanics.

Critics argue that a humanoid robot cannot achieve the performance of a human in the foreseeable future. They also point to the rule "form follows function": the human body is conceivably unsuitable for certain tasks. This often contradicts the tasks for which the deployment of robots is desirable.

The current developments and investments in the USA and China compared to the limited resources of european companies raise the question of how both companies and the German society should position themselves regarding humanoid robots in the future.

All references to this text can be found here.

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Potential for production and logistics in Germany

For these reasons, the aim of the study is to evaluate the application potential of humanoid robots in production and logistics in Germany and to obtain the opinions of German industry.

The results and recommendation for actions derived from this study are intended to contribute to the development of a high-profile strategy towards humanoid robots for Germany.

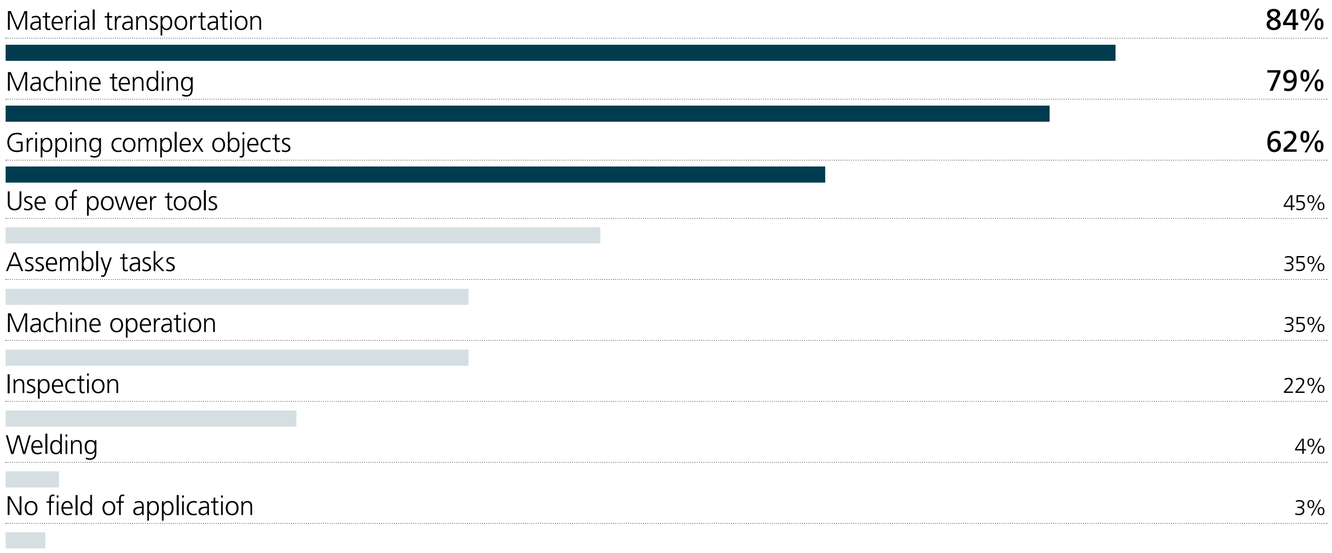
An overview and the results of the study are shown in the following pages. Additional analyses on different sectors, company size and other classifications or individual statistics can be requested from Fraunhofer IPA.

Results

2.1 Result

Technological topics 1/3

Application scenarios for humanoid robots in production and logistics



(n=113), fields of application for humanoid robots, multiple selections possible

Versatile tasks in logistics and production

- The main application scenarios mentioned are simple tasks: material transportation in logistics and provision in production, order picking and machine tending.
- Humanoid robots should be able to take on a variety of tasks as jumpers or assistants.

To be profitable, humanoid robots must stand out from other automation solutions in terms of their flexibility.«

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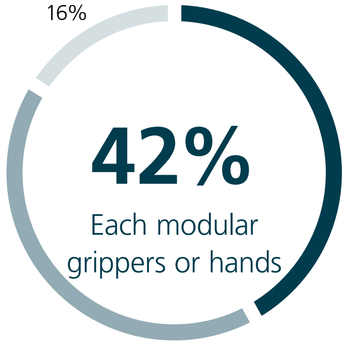
2.1 Result

Technological topics 2/3

Top 5 skills in demand

- Indoor navigation
- Environmental surveillance
- Allocating and sorting objects
- Walking on flat ground
- Carrying loads

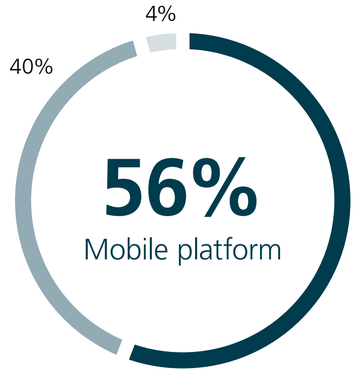
End effectors in demand



Modular grippers	42%
Hands	42%
Specific gripper	16%

(n=113)

Type of locomotion in demand



Mobile platform	56%
Legs	40%
Stationary	4%

(n=113)

Discrepancies in sensitivity

- The skills in demand correspond to the most frequently named application scenarios: material handling, machine tending, gripping complex objects (order picking, provision of material).
- A comparison of the required capabilities with the current capabilities of humanoid robots reveals major discrepancies in terms of the sensitivity and accuracy of the end effectors and the ability to cooperate with humans, among other things.

Only about 40 percent of those surveyed consider legs and human-like hands to be necessary.«

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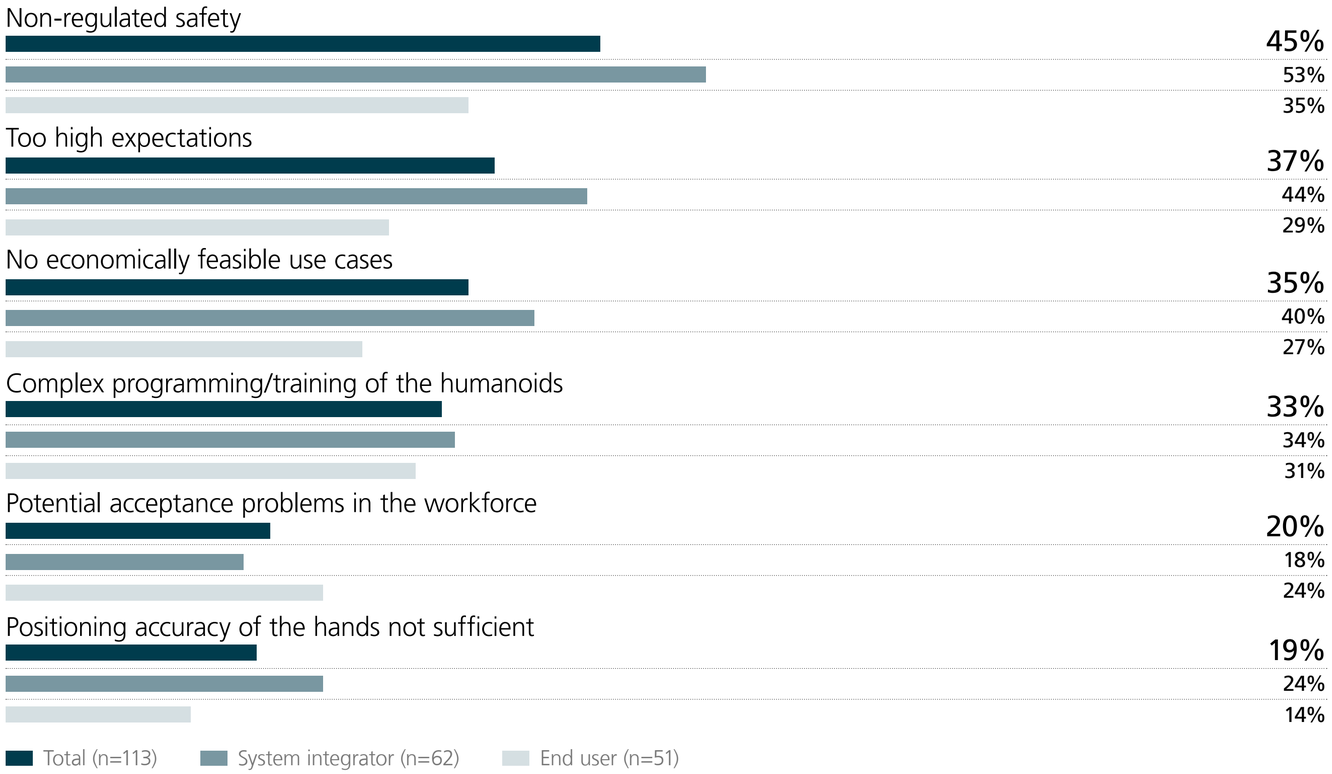
2.1 Result

Technological topics 3/3

Biggest obstacles for humanoid robots



Safety issues and acceptance problems

- The lack of safety regulations for deploying humanoid robots is seen as the biggest obstacle.
- System integrators currently see a greater number of obstacles compared to potential end users.
- End users have major concerns about the acceptance of humanoid robots.

For the use of humanoid robots in Germany humanoid manufacturers must prove their safety and reliable capabilities for customers.«

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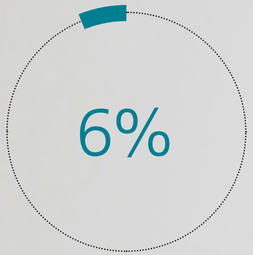
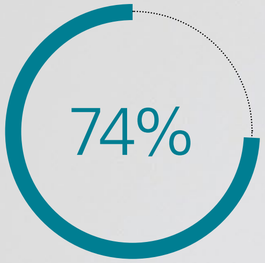
2.2 Result

Economic topics 1/2

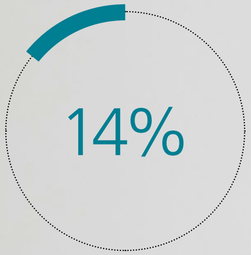
Expected time to market maturity of humanoid robots



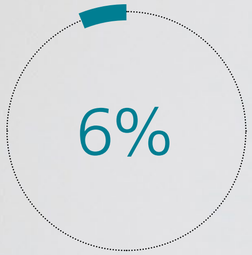
< 3 years



3 to 10 years



In 10 years at the earliest



Not foreseeable

(n=89)

Expected market maturity by sector

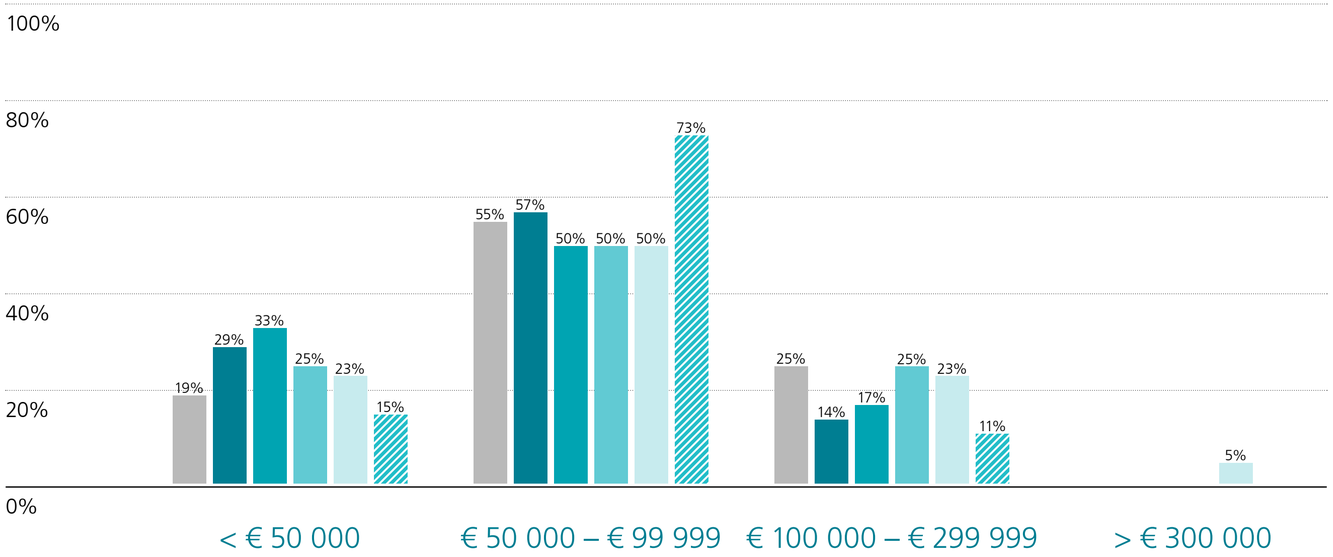
- In the medium term, it is generally assumed that humanoid robots will be implemented in production.
- The logistics, food and textile industries are more optimistic about the market maturity of humanoid robots than other sectors.

Around 80 percent of respondents consider the use of humanoid robots in production and logistics to be a realistic prospect within the next 10 years.«

2.2 Result

Economic topics 2/2

Willingness to pay for humanoid robots



Total | 0–50 Employees | 51–100 Employees | 101–250 Employees | 251–1 000 Employees | > 1 000 Employees

(n=93), breakdown by number of employees, answer options given, assumption: work performance of the humanoid corresponds to that of half a human over a period of at least five years

Different willingness to pay

- On average, large companies are more willing to spend more money on a humanoid robot than SMEs.
- The majority of companies have a willingness to pay of less than € 100 000.

The target price of under € 50 000 for humanoid robots envisaged by manufacturers is met with the votes from industry.«

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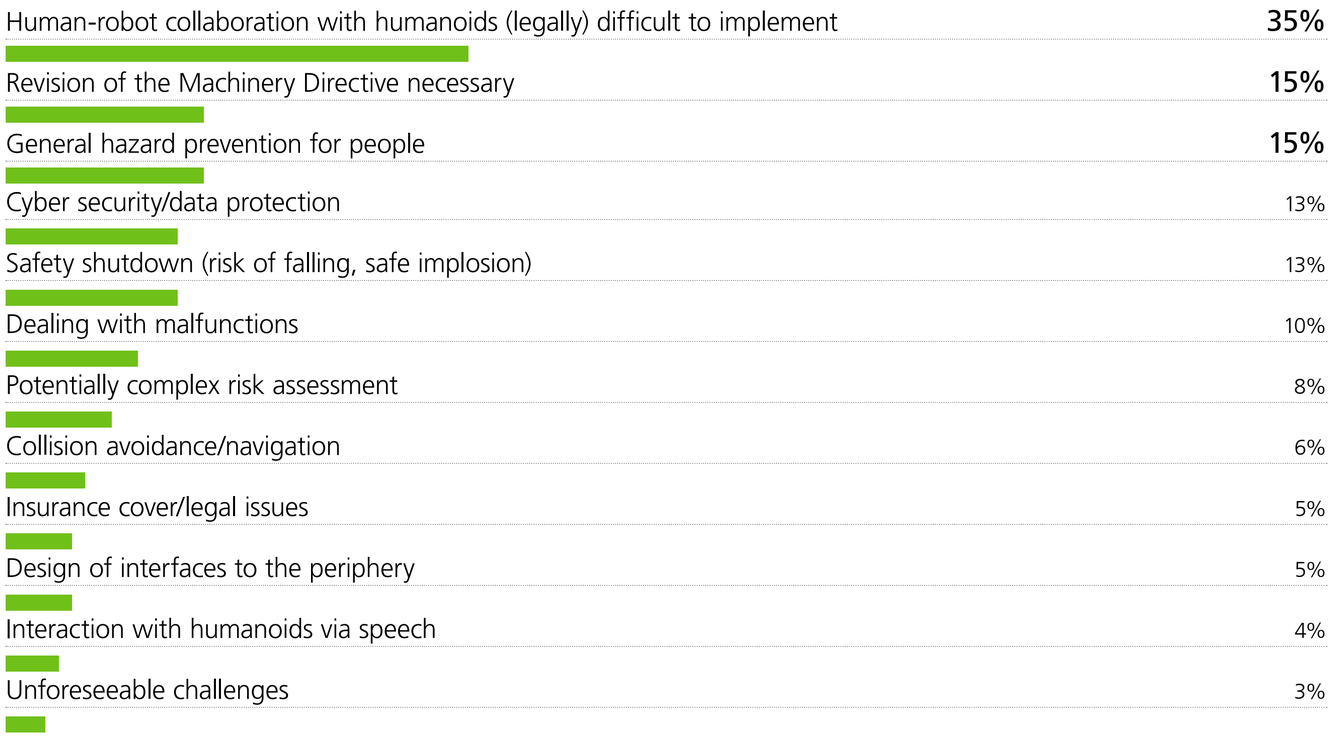
2.3 Result

Legal topics

Safety challenges with humanoid robots
X % of respondents mentioned the following points:



(n=80), free text answers, multiple answers possible

Challenges and necessities

- The current legal requirements are not sufficient for humanoid robots and must be adapted accordingly.
- Humanoid robots are inherently unstable due to their physical form.

When dealing with humanoid robots, the physical safety of people is considered to be the greatest legal challenge.«

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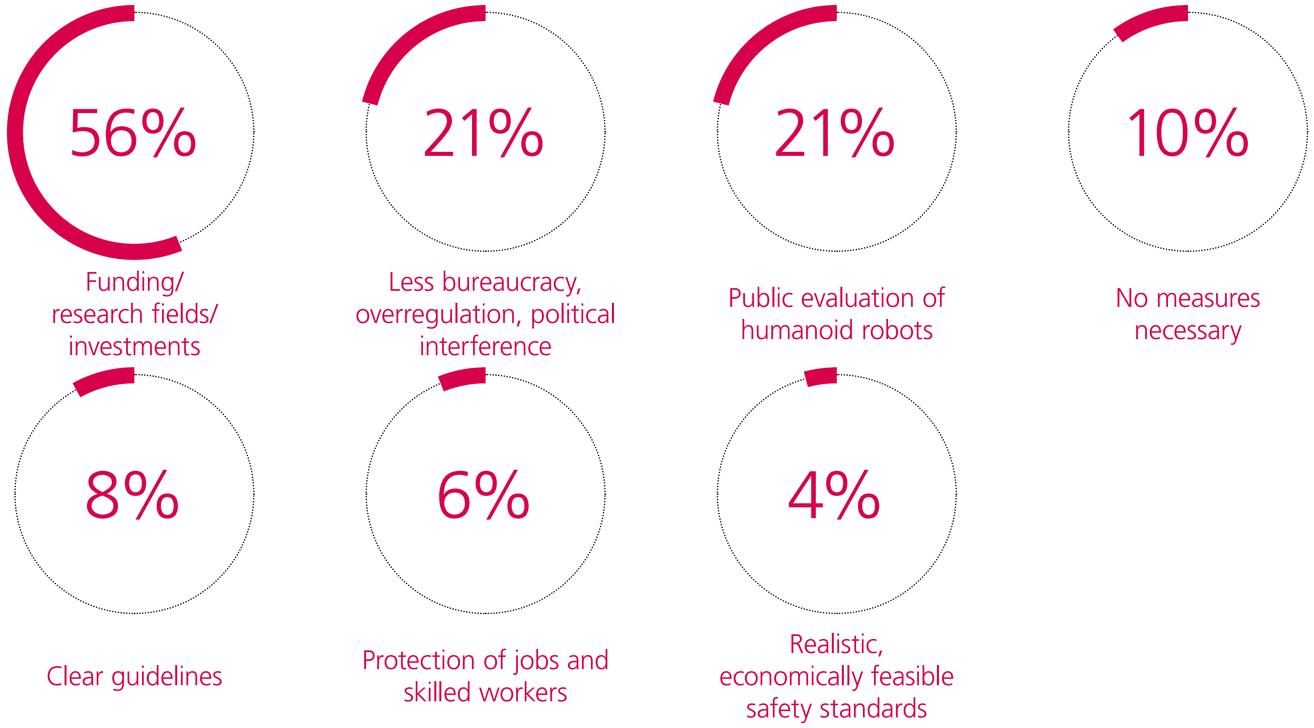
2.4 Result

Political topics

Necessary political initiatives to strengthen Germany as a location for the development and use of humanoid robot technology



(n=48), free text answers, clustered

Needs on the company side

- Companies want funding to evaluate new technologies.
- Politicians should create clear framework conditions through unambiguous guidelines and give companies as much freedom as possible when it comes to testing.

Companies would like to see more funding of humanoid robotics in order to identify potential and promote its use in industry.«

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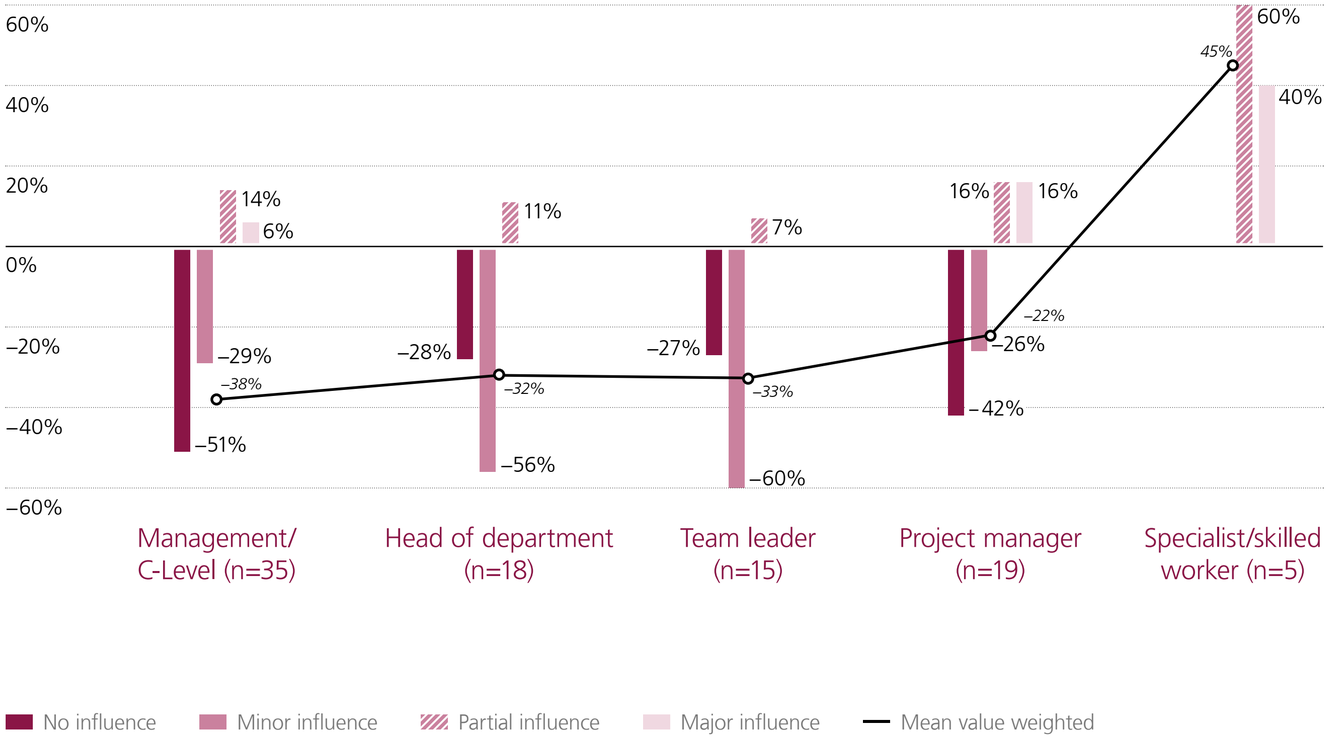
2.5 Result

Social topics 1/2

Humanoids as a possible cause of impending job loss depending on the respondent's position

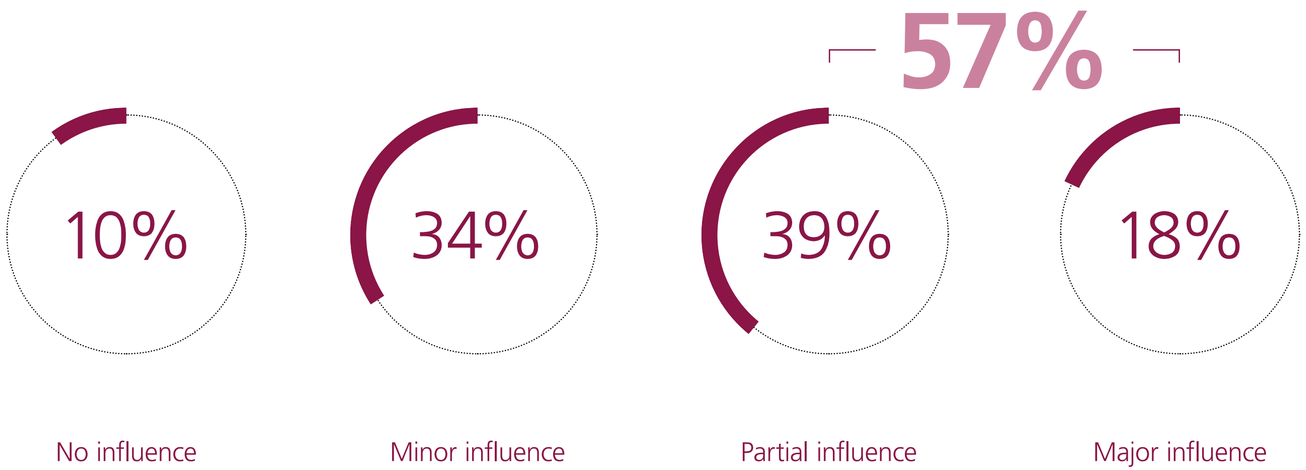


Note: Negative percentages mean no/minor influence. Positive percentages mean partial/major influence. The mean value was weighted with 0.75 (no/major influence) and 0.25 (minor/partial influence). The higher the mean value, the greater the influence of the factor.

2.5 Result

Social topics 2/2

Influence of a lack of employee acceptance when purchasing humanoid robots



n=113

Acceptance among the workforce

- 57 percent state that acceptance problems among employees would have an influence on the decision to purchase a humanoid robot.
- One in three end users see a lack of acceptance among employees as one of the biggest obstacles to the use of humanoid robots.
- In large companies with more than 1 000 employees, a lack of employee acceptance would have a greater influence on the decision not to use humanoid robots than in smaller companies.

Humanoid robots are not seen as “job killers”, but their acceptance within the workforce will influence purchasing decisions.«

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Conclusion and recommendations for action

Humanoid robots as multi-purpose robots with their versatile application possibilities and flexible gripping technology have the potential to become a game changer in existing factories.

However, with today's level of technological maturity, the use of humanoid robots in production and logistics is not yet feasible due to the challenges identified, particularly in interaction with humans and the frequently required high process speeds and qualities.

Conclusion and recommendations for action

1 Development of software-based safety functions and features

2 Development and optimization of precise handling and sensitivity of end effectors

3 Easy programming and optimization of humanoid robots for their applications

4 Technologies for sensing the environment and responding accordingly

5 Creating a standard/technical specification comparable to that for human-robot collaboration (ISO TS 15066)

6 Create legal evaluation options for companies

7 Funding of critical and differentiating technologies, in particular the growth financing of start-ups

» Contact

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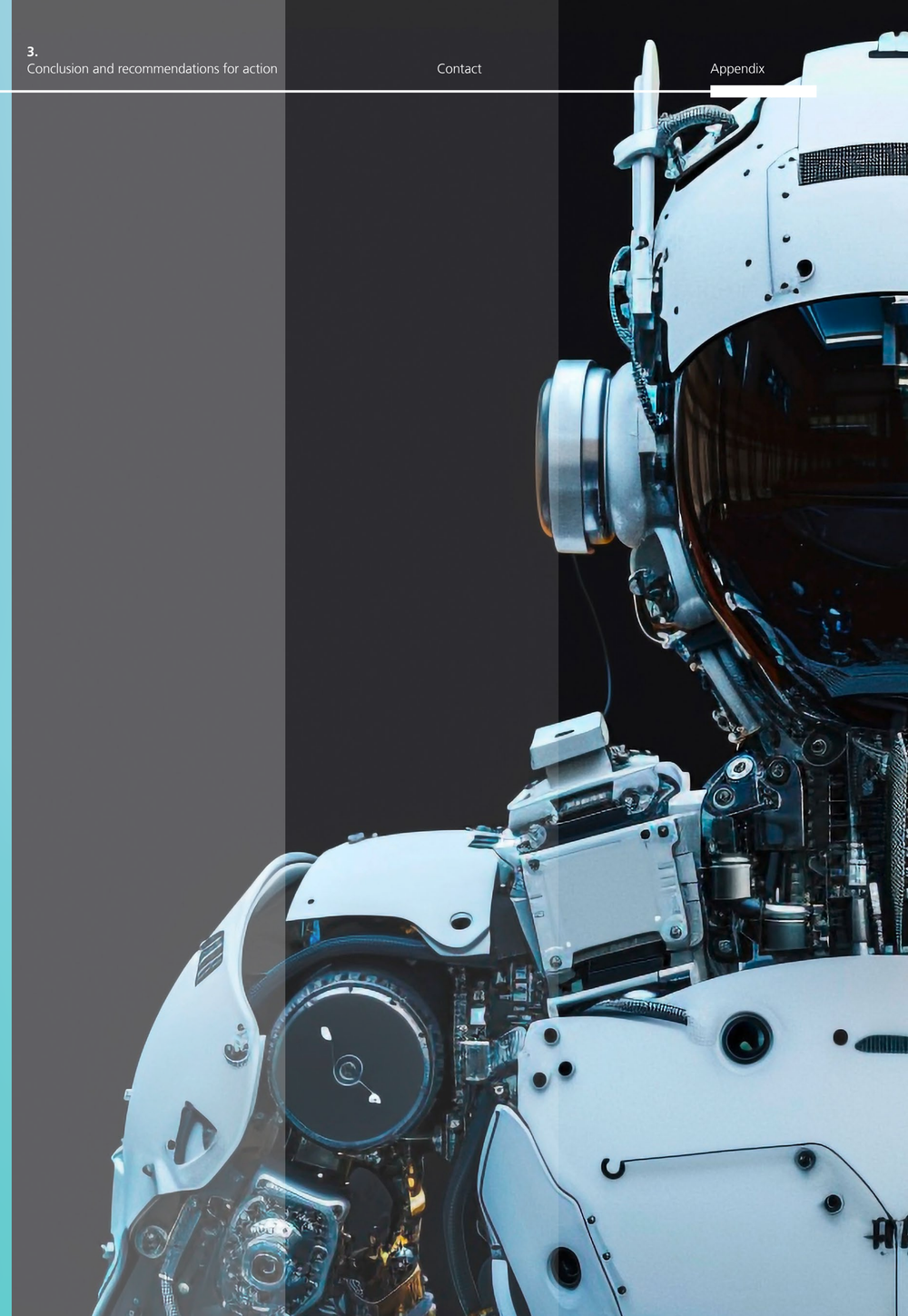
Appendix



Methodology

1. LITERATURE RESEARCH

As a basis for the study, a literature research was conducted, which included scientific publications, technical articles and published videos from manufacturers of humanoid robots as well as business news from the last three years. The aim was to gain an understanding of the developments of humanoid robots in recent years, to define their current and potential market-ready capabilities and thus to generate the basis for the market research.

2. EXPERT INTERVIEWS

Building on the literature research potential applications, technical and economic requirements as well as obstacles and framework conditions were discussed and evaluated in structured expert interviews.

System integrators and potential end users of humanoid robots in Germany were specifically interviewed. The focus of the interviews was to collect qualitative data that would provide information on the current state of the technology, existing challenges and future developments.

3. ONLINE SURVEY

In the third step, a broad-based survey was conducted via the German Engineering Federation (VDMA) to reach as many participants from industry as possible. A standardized questionnaire was used to collect quantitative data on the topics of research needs, the influence of humanoid robots on production processes, and the willingness of companies to pay. The findings from the expert interviews served as the basis for the questionnaire.

4. EVALUATION OF THE DATA

The final phase of the study involves analyzing the collected data. The qualitative results from the expert interviews are combined with the quantitative data from the survey in order to draw a comprehensive picture of the current situation and future developments.

A comprehensive analysis of the results was carried out on the basis of the PESTEL structure.

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