UPDATE

2026 HUMANOID ROBOT STUDY

MARKET DEVELOPMENT, TECHNOLOGICAL MATURITY AND POTENTIAL FOR COMPANIES.

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// NEXERY.
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&
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PREFACE

Dear Readers,

With the present 2026 Humanoid Robot Study, we build on the findings of our 2025 study. Compared with the previous year, it is now even more evident how rapidly and intensely the market for humanoid robotics is evolving. What until recently was often regarded as a future vision is increasingly becoming a tangible industrial and strategic field of action. Advances in artificial intelligence, simulation, sensors, actuators, and robotics software have significantly enhanced the capabilities of modern systems and further accelerated technological development. At the same time, the number of companies entering the market with their own solutions, platforms, or market-ready concepts has risen significantly within just one year. The market is therefore expanding not only in quantitative terms, but also in its technological breadth, strategic relevance, and competitive intensity.

This momentum reflects a visible maturation process. Humanoid robotics is increasingly moving beyond the experimental development stage toward concrete commercial and industrial deployment scenarios. Today’s systems are demonstrating clear progress in mobility, perception, manipulation, and task execution. As a result, the potential of the technology is becoming much more tangible: it is no longer visible only in isolated demonstrations or visionary concepts, but has now been substantiated across a wide range of use cases. These span industry and manufacturing, logistics, healthcare, services, security, and education, as well as household and personal assistance scenarios. Particularly in industrial contexts, it is becoming clear that humanoid robotics can increasingly be understood as a general-purpose technology capable of supporting – or, in the future, taking over – a broad variety of manual tasks in environments designed for humans.

Despite this progress, significant technological challenges remain. At the center of these is the fact that the level of autonomy required for everyday use in unstructured environments is not yet available. While initial industrial deployment scenarios can already be enabled by intermediate levels of autonomy – allowing clearly defined tasks to be executed autonomously under human supervision – broad everyday use requires substantially more advanced capabilities: robust operation in changing environments, situational decision-making, reliable exception handling, and consistently stable behavior outside structured settings. This is precisely where a key maturity boundary of the technology currently lies. In addition, there are still substantial challenges related to energy efficiency, robust object recognition under real-world conditions, safe human-robot interaction, fine motor manipulation, and continuous, reliable operation under industrial requirements. As computing power, actuator performance, and operating times increase, thermal management, cooling, and overall system reliability are also becoming increasingly important.

At least equally demanding is the implementation of the technology in real business environments. The challenge is no longer limited to developing technically functional systems, but rather lies in introducing them in a way that is economically viable, scalable, and organizationally compatible. Companies must identify suitable use cases, ensure integration into existing processes and systems, build technological capabilities, establish partner and supplier models, and at the same time create the organizational preconditions for piloting and scaling.

It is precisely at the intersection of technical maturity, operational integration, and economic scalability that it will be decided whether technological potential can be translated into productive deployment.

PREFACE

Market perception is also changing. In recent years, public interest in humanoid robotics was driven primarily by industrial use cases, particularly in manufacturing, logistics, and other structured operating environments. However, attention is shifting significantly toward use cases in the private household and in personal assistance. The technology is therefore no longer viewed solely as an industrial automation solution, but increasingly also as a potential system for everyday, consumer-oriented applications. Nevertheless, from today's perspective, there are strong indications that the first broad wave of economic scaling will still occur primarily in industrial environments, while private household applications are more likely to follow a medium- to long-term development trajectory.

At the same time, the global technology landscape in this field is being reshaped. The current momentum is driven above all by players from China and the United States. Germany no longer plays a defining role in the technological development of humanoid robotics. This finding is strategically significant, as it makes clear that companies in Germany will be less able to derive their position from domestic technological leadership and will instead need to rely more heavily on partnerships, rapid access to international ecosystems, and the consistent development of concrete application fields.

The central message of this study is therefore clear: humanoid robotics is no longer a distant future topic, but a market undergoing accelerated technological, economic, and strategic development. The potential of the technology has now become visible across a wide variety of application areas. The decisive task now is to assess these developments with discipline, identify realistic deployment opportunities at an early stage, and systematically establish the prerequisites for piloting, scaling, and integration. This study is intended to make a well-founded contribution to that effort.

Tobias Bock

CONTENT

//01 Facts and Figures

Following the strong momentum observed in recent years, humanoid robotics is entering a new phase of industrial relevance. Advances in artificial intelligence, perception systems, and electromechanical actuation have significantly improved robot mobility, dexterity, and task execution. Compared to earlier generations, current humanoid platforms demonstrate higher movement speed, improved manipulation capabilities, and increasingly reliable autonomous operation in complex environments.

As a result, humanoid robots are moving beyond experimental prototypes toward early commercial deployment. Several technology companies and robotics startups are preparing large-scale production, with initial industrial deployments expected from 2026 onward. Primary application areas include manufacturing, logistics, warehouse operations, and other structured environments where labor shortages and repetitive manual work create strong incentives for automation.

Market expectations remain highly dynamic. Current projections suggest that the global humanoid robot market could reach millions of deployed units by 2030. This development is driven by substantial capital inflows, growing involvement of major technology companies, and rapid progress in AI-driven robot control.

From an application perspective, humanoid robots are particularly suited for environments originally designed for humans. Their anthropomorphic form factor allows them to interact with existing infrastructure, tools, and workflows without requiring major redesign of production systems.
Early analyses indicate that in sectors such as manufacturing and logistics, more than 60% of manual operational tasks could theoretically be supported or partially automated by humanoid systems over the next decade.

At the same time, the economic viability of humanoid robotics is improving. Advances in AI-based control, simulation-driven training, and modular hardware design have led to significant performance gains, while hardware costs are gradually declining as supply chains mature and components become standardized.

Looking ahead, further cost reductions are expected as production volumes increase. By the end of the decade, the average unit price for industrial humanoid robots could fall to around $55,000, significantly lowering barriers to adoption. In suitable applications, these developments could enable short payback periods – potentially below one year – particularly in labor-intensive environments facing workforce shortages.

Our survey results confirm the growing strategic relevance of the technology. 73% of respondents indicate concrete plans to implement Embodied AI or humanoid robotics in the near- to mid-term, while many organizations already see strong potential for cost reduction (mentioned by 70% of the surveyed) and efficiency improvements (mentioned by 72% of the surveyed).

Overall, humanoid robots are emerging as a key technology for the next wave of industrial automation. While large-scale deployment will depend on continued improvements in reliability, safety, and cost efficiency, current developments indicate that humanoid systems may play a central role in addressing labor shortages and expanding the scope of automation across multiple industries.

//02 Market Volume & Market Development

Humanoid robotics is transitioning from experimental research to an emerging industrial market. Advances in AI, robotics hardware, and computing infrastructure are driving rapid growth in both the number of developers and robot platforms worldwide.

From Industrial Robotics to the Humanoid Robotics Market

The development of robotics has progressed through several technological waves over the past six decades. What began as simple programmable industrial machines has gradually evolved into increasingly sophisticated robotic systems capable of interacting with complex environments. This long-term technological evolution laid the foundation for the emergence of humanoid robotics as a new development field. The first major milestone occurred in 1961 with the deployment of *Unimate*, the world's first industrial robot used in manufacturing. This marked the beginning of programmable automation in industrial production and established robotics as a key industrial technology. In the following decades, research institutions began to explore robotic systems capable of mobility and human interaction. Early humanoid concepts such as *WABOT* (1967) demonstrated the vision of robots capable of interacting with human environments. During the following decades, advances in computing power, sensors, and control systems enabled increasingly capable robotic platforms. Projects such as Honda's *ASIMO* (2000) represented an important step toward stable bipedal locomotion. Since the early 2000s, humanoid robotics has gradually evolved from experimental research platforms toward more capable systems. Robots such as *NAO* (2006), NASA's *Robonaut R2* (2010), and Tesla's *Optimus* (2021) demonstrated increasing capabilities in perception, mobility, and interaction. In recent years, advances in artificial intelligence and simulation-based training have accelerated the development of humanoid robots designed for industrial and commercial deployment.

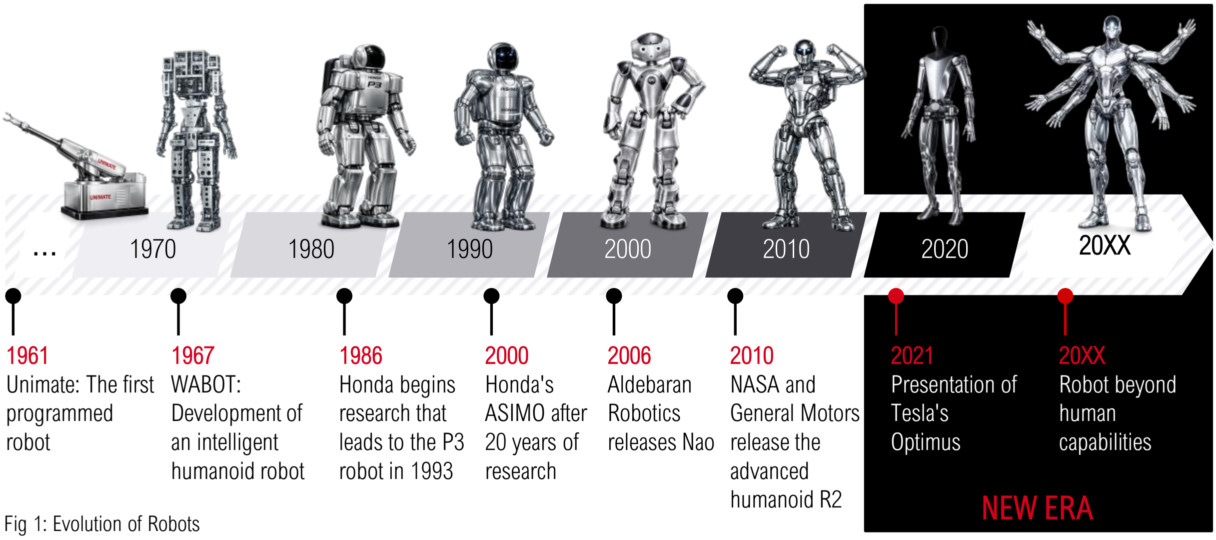


Fig 1: Evolution of Robots

A key advancement in the development of humanoid robotics lies in the growing ability of systems to communicate in natural human language. While earlier generations of robots were primarily controlled through predefined commands or specialized interfaces, modern AI models now enable a far more intuitive interaction between humans and machines.

This development represents a technological milestone, as it fundamentally changes how humanoid systems can be used: robots are no longer limited to executing tasks, but are increasingly capable of understanding, interpreting, and acting based on contextual human instructions. As a result, the complexity of operation is significantly reduced, making the technology more accessible to non-technical users.

This form of interaction becomes particularly relevant in dynamic and unstructured environments. Language-based communication enables more flexible task control, faster adaptation to changing conditions, and more efficient collaboration between humans and robots.
Natural language is therefore emerging as a central interface for humanoid robotics, playing a critical role in the transition from highly specialized systems toward more general-purpose robotic applications.

Global Expansion of the Humanoid Robotics Vendor Ecosystem

COMMERCIAL VENDORS

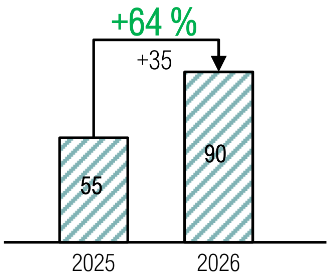


Fig 2: Commercial vendors developing legged humanoid robots from 2025 to 2026

of companies developing humanoid robots has increased rapidly in recent years. As of 2026, approximately 90 commercial vendors worldwide are actively developing legged humanoid robots, compared with around 55 companies in 2025. This sharp increase illustrates the growing strategic importance of humanoid robotics as a future automation technology and reflects rising investment across the sector.

COUNTRIES OF ORIGIN

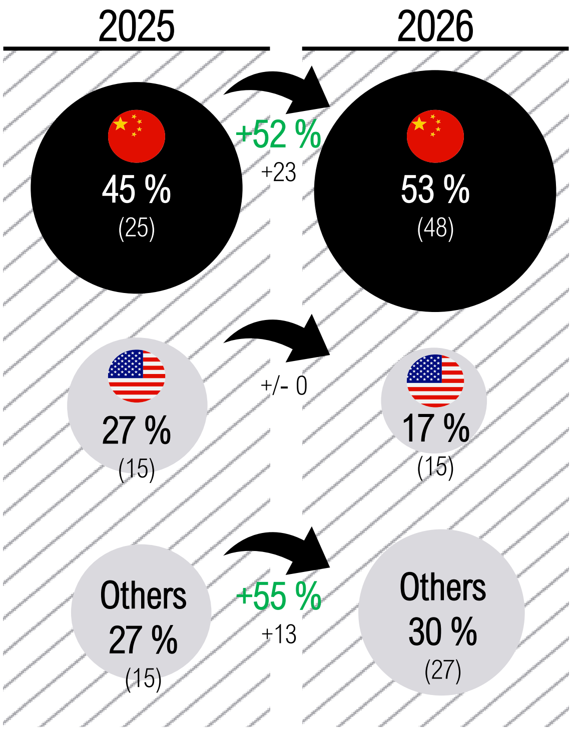


Fig 3: Development of the countries of origin of manufacturers from 2025 to 2026 | *n = 90 commercial vendors*

The geographical distribution of vendors shows a strong concentration in a limited number of technology ecosystems. China currently represents the largest share of commercial humanoid robot developers, accounting for approximately 53% of the global vendor landscape. In absolute terms, the number of Chinese vendors increased noticeably from 25 companies in 2025 to 48 companies in 2026.

Notice: Representation of the Top 16 humanoid robot models | HQ = Company headquarters
Source: 2026 NEXERY. humanoid market analysis

Despite this substantial growth, China's share of the global market increased by around 8 percentage points, reflecting the country's strong expansion within the rapidly growing humanoid robotics ecosystem.

The United States remains the second most important development hub. While the number of U.S.-based vendors remained stable at around 15 companies between 2025 and 2026, the country's relative share of the global ecosystem declined from 27% to approximately 17% as the overall market expanded rapidly and a growing number of new vendors entered the field.

At the same time, the share of vendors categorized as other regions increased from 27% to around 30%, reflecting the entry of new companies from Europe, Asia, and other emerging robotics ecosystems.

Expanding Portfolio of Humanoid Robot Platforms

The rapid growth of vendors developing humanoid robots is directly reflected in a growing portfolio of robot platforms entering the market. As more companies invest in humanoid robotics, the number of available robot models has increased significantly in recent years.

While approximately 140 humanoid robot models were identified globally in 2025, the number has increased to around 284 models in 2026, highlighting the rapid expansion of humanoid robotics development. Among these, 249 robots utilize either legged or wheeled mobility architectures.

Beyond geographic distribution, the mobility architecture of humanoid robots has also evolved. Earlier generations of humanoid platforms often relied on wheeled mobility concepts, which offered greater stability and reduced mechanical complexity during early development phases. In this context, wheeled platforms can be understood as an intermediate step in the evolutionary progress of humanoid robotics, enabling developers to test perception, manipulation, and autonomy capabilities before mastering the considerably more complex challenge of stable bipedal locomotion.

As hardware, actuators, and AI-based motion control systems have improved, an increasing number of developers have shifted toward bipedal locomotion. This technological transition is reflected in the current distribution of mobility concepts. In 2025, approximately 73% of humanoid robot models used legged locomotion, while 27% relied on wheeled or hybrid mobility systems.

In 2026, a total of 249 humanoid robot models feature either legged or wheeled mobility architectures. Of these, around 65% are legged systems, while approximately 35% use wheeled mobility concepts.

ROBOT MOBILITY

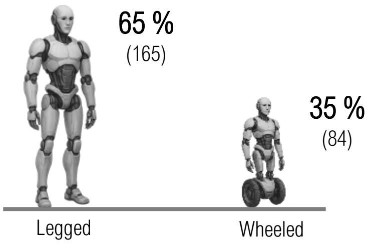


Fig 4: Development of the robot mobility legged & wheeled | n = 249 Robots

While fully legged humanoid robots are often seen as the long-term evolutionary target, systems without human-like legs – such as wheeled or hybrid mobility platforms – are already proving highly suitable for industrial applications. In many operational environments, the advantages of wheeled mobility, including greater stability, lower mechanical complexity, and higher energy efficiency, outweigh the benefits of bipedal locomotion.

Particularly in structured industrial settings such as manufacturing facilities, warehouses, and logistics centers, mobility requirements are typically predictable and optimized for flat surfaces. In these contexts, wheeled humanoid systems can deliver reliable and efficient performance while reducing technical risks and system costs.

Source: 2026 NEXERY. humanoid market analysis

Humanoid robots are particularly well suited for brownfield environments, where existing production systems, infrastructure, and workflows are already designed for human workers. Instead of requiring extensive redesign of facilities or production lines, humanoid systems can operate within existing layouts, interact with standard tools, and perform tasks in environments originally optimized for human labor. This ability significantly lowers the barriers to automation in many industrial facilities where traditional automation solutions would require costly process redesign or infrastructure changes.

As a result, non-bipedal humanoid robots should not be viewed as a transitional compromise, but rather as a pragmatic and economically viable solution for early deployment scenarios. They enable companies to realize value from humanoid robotics at lower complexity levels while the technological maturity of fully legged systems continues to evolve.

In the near to mid term, wheeled and hybrid humanoid platforms are therefore likely to play a central role in the industrial adoption of humanoid robotics, particularly in applications where robustness, efficiency, and scalability are more critical than full human-like mobility.

Source: 2026 NEXERY. humanoid market analysis

//03 Industry Interest

Interest in Embodied AI increases rapidly across industrial companies. To better understand how organizations evaluate this emerging technology and when they expect deployment, we surveyed 152 industry participants. The results provide insights into adoption intentions, expected timelines, key application areas, and the organizational readiness required for successful implementation.

Industry Interest in Embodied AI Systems

The survey results indicate a strong and growing interest in Embodied AI systems among industrial organizations.

PLANNING FOR IMPLEMENTATION

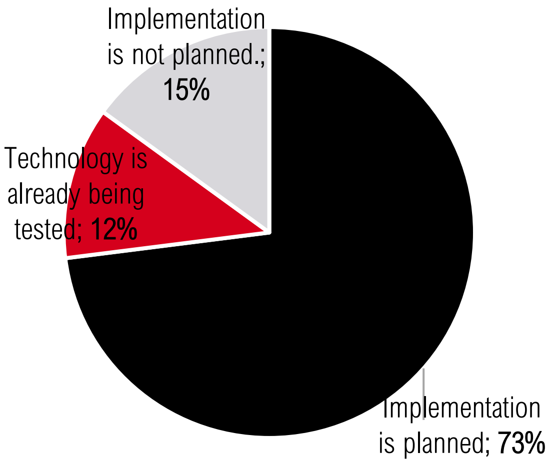


Fig 5: Survey results regarding plans for the implementation of embodied AI (humanoids) in industrial companies | *n* = 152 interviewees

73% of respondents state that they plan to deploy Embodied AI technologies, while 15% currently have no plans to introduce such systems. In addition, 12% report that such systems are already in pilot use.

This high level of interest reflects the growing awareness of humanoid robots and AI-driven automation as potential solutions to structural challenges such as labor shortages, rising operational costs, and increasing efficiency requirements. While many companies are still evaluating possible deployment scenarios, Embodied AI is already becoming part of strategic technology planning in many organizations.

Overall, the results show that humanoid robotics is gradually moving from a purely experimental topic toward a relevant technological option for future industrial operations.

Expected Adoption Timeline

The survey also examined when companies expect to deploy AI-supported physical systems. The results indicate a relatively short adoption horizon. 42% of respondents expect implementation within the next one to two years, while 29% anticipate deployment within three to five years.

EXPECTED IMPLEMENTATION

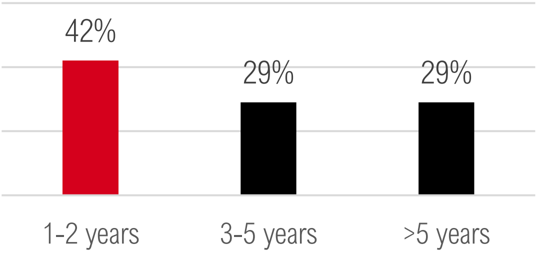


Fig 6: Survey results regarding the planned timeframe for the implementation of embodied AI (humanoids) in industrial companies| *n* = 111 interviewees

Source: 2026 NEXERY. Embodied AI survey

In contrast, 29% expect adoption only after more than five years.

Overall, the findings suggest that adoption will likely increase gradually as companies gain experience through pilot projects and early deployments. Furthermore, humanoid robotics is mainly considered as a near- to mid-term technology rather than a distant future concept.

Application Areas

Respondents clearly identified core operational processes as the most promising application areas for Embodied AI systems. The highest potential is seen in logistics, selected by 96% of respondents, followed by manufacturing, cited by 81%. These environments often involve repetitive and structured tasks that are well suited for robotic automation.

EXPECTED EMBODIED AI APPLICATIONS

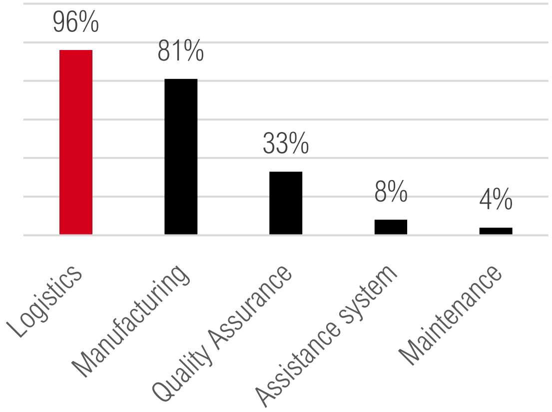


Fig 7: Expected implementation of Embodied AI | *n* = 152 interviewees

Other application areas were mentioned less frequently, with 33% for quality assurance and assistive systems and maintenance-related tasks each cited by fewer than 10% of respondents.

Expected Business Value

The expected benefits are primarily economic. Efficiency improvements were mentioned by 72% of respondents, followed by cost reductions at 70%. These results demonstrate that companies mainly view Embodied AI as a tool to increase productivity and reduce operational costs.

EXPECTED BUSINESS VALUE

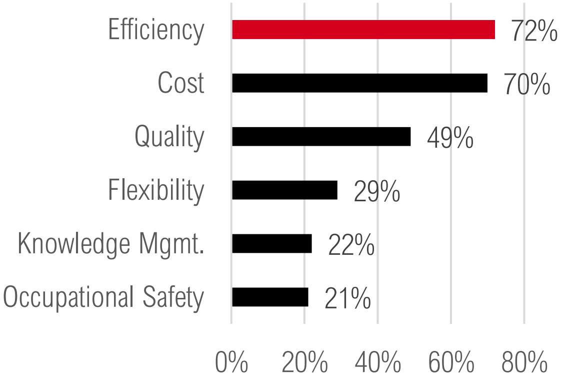


Fig 8: Expected implementation of Embodied AI | *n* = 152 interviewees

In addition, many respondents associate the adoption of humanoid robotics with addressing structural workforce challenges, particularly labor shortages, while also expecting improvements in operational quality and process consistency.

Organizational Readiness and Adoption Barriers

Despite strong strategic interest in Embodied AI, survey results indicate that organizational readiness remains uneven across companies. Many respondents report only moderate readiness to adapt internal processes and systems for the integration of humanoid robotics. This is reflected in the barriers companies currently associate with deployment. Data quality is identified as a key challenge by 64% of respondents, followed by integration into existing systems and processes, cited by 61%. Cost considerations also play a central role, with 60% of organizations highlighting financial constraints as a barrier.

Source: 2026 NEXERY. Embodied AI survey

Furthermore, employee acceptance emerges as a critical factor. In the survey, 36% anticipate concerns about job losses, while 32% expect reservations regarding usability and trust. Liability issues are mentioned by 29% of respondents, while 25% point to concerns about losing autonomy over processes. Another 16% highlight concerns about limited transparency in AI-driven decisions.

These findings suggest that broader deployment will depend not only on technological progress but also on companies' ability to adapt structures, processes, and workforce integration.

Potential per Industry

The industry pattern shows a heterogeneous maturity and value perception for humanoid robots. Electronics, with 52 percent indicating high potential, as well as chemicals and food, both above the overall average, assess the technology disproportionately positively. This aligns with environments dominated by standardized, repetitive, and quality-critical tasks, combined with high requirements for process stability. In such settings, humanoid robotics can be understood as a flexible automation building block that directly addresses labor shortages and error reduction, which are the two most frequently cited problem dimensions in the study.

At the same time, mechanical engineering sits close to the overall average. This suggests that perceptions vary strongly with product variance, batch size, product complexity, and equipment heterogeneity. These factors typically increase integration effort and therefore reduce economic attractiveness.

The clear negative outlier is automotive, with only 16 percent indicating high potential and 51 percent indicating low potential. This is not primarily a reflection of low value but rather of a different reference system. Automotive production already operates at very high levels of automation and relies on well-established alternatives such as classical industrial robotics and specialized automation cells. In this context, humanoid systems must demonstrate a clear incremental benefit over proven solutions, particularly under strict requirements regarding safety, compliance, integration complexity, and takt time.

An important additional insight is that the perceived potential must always be evaluated in relation to the existing level of automation. Humanoid robots are not expected to replace classical industrial robots. Instead, their primary value lies in enabling the automation of processes that have so far remained manual due to cost constraints or high operational complexity.

From an interpretation standpoint, these findings reflect subjective assessments of potential. They are strongly influenced by conceptual understanding, the respondent's level of knowledge, and the maturity of the production and logistics environment. Differences in sample sizes across industries further increase the sensitivity of some results. Overall, the pattern indicates that market adoption will be driven less by generalized narratives and more by industry-specific value proofs.

EXPECTED POTENTIAL PER INDUSTRY

Fig 9: Presentation of the status quo of industrial automation and the expected additional potential from humanoid robots | *n* = 152 interviewees

Source: 2026 NEXERY. Embodied AI survey

//04 Technological Maturity Level

Humanoid robotics is entering a new phase of technological maturity. Recent advances in artificial intelligence, simulation, sensing, and electromechanical actuation have significantly improved the capabilities of modern humanoid systems. At the same time, the market is gradually moving beyond experimental prototypes as leading vendors begin establishing pilot deployments and early industrial partnerships.

Industrialization Readiness across Humanoid Robot Vendors

Although the number of companies developing humanoid robots has increased sharply, the industry as a whole remains in an early commercialization phase. A growing number of vendors have successfully developed functional prototypes and early pilot systems, but only a small subset is currently moving toward repeatable, large-scale production. This gap between technical feasibility and industrial scalability remains one of the defining characteristics of the market.

The challenge is not only to build a robot that works, but to build one that can be manufactured in volume, maintained reliably, and integrated into existing industrial operations. This requires robust supply chains, stable software-hardware integration, repeatable quality control, and commercially viable deployment models.

At the same time, signs of industrialization are becoming more visible. Several vendors have begun establishing dedicated manufacturing facilities and announcing production roadmaps aimed at thousands of units annually. Early deployments are emerging in logistics, manufacturing, and warehouse environments where robots can perform repetitive physical tasks under structured conditions.

Nevertheless, large-scale deployment across industries has not yet materialized. Most robots currently operate in controlled pilot environments where the technology can be tested and refined. The vendors most likely to succeed in the coming years will be those that are able not only to develop advanced humanoid platforms but also to establish scalable manufacturing capabilities, reliable supply chains, and viable deployment models.

Key Technologies Enabling the Humanoid Robotics Ecosystem

The rapid progress of humanoid robotics is increasingly driven by a broader technology ecosystem rather than by robot manufacturers alone. Modern humanoid robots are the result of an integrated technology stack that combines artificial intelligence, high-performance computing, advanced sensors, simulation environments, and sophisticated electromechanical components.

High-performance AI computing platforms play a particularly important role in enabling robots to process sensory information, plan movements, and execute complex tasks in real time. Companies such as NVIDIA have emerged as central infrastructure providers for the humanoid robotics ecosystem, offering hardware and software platforms including Jetson, Isaac, and Omniverse, which enable large-scale simulation, AI training, and real-time robot control.[2]

Source: [2] NVIDIA.com

These platforms allow developers to train robot behavior in virtual environments before transferring these capabilities into real-world systems, significantly accelerating development cycles.

Beyond computing infrastructure, humanoid robots depend on a wide network of specialized component suppliers. In particular, advances in sensors, actuators, and precision robotics components are essential for enabling stable locomotion and dexterous manipulation. Leading industrial technology providers such as Bosch, Intel, and NXP are increasingly contributing technologies in areas such as embedded computing, sensing systems, and robotics hardware.

In addition, several established industrial technology companies are actively participating in the emerging humanoid robotics ecosystem. For example, companies such as Schaeffler, BMW, and Hyundai have begun exploring humanoid robotics applications within manufacturing environments. Meanwhile, technology and robotics firms such as GXO Logistics, Agility Robotics, Tesla, and Sanctuary AI are developing deployment scenarios and operational integration strategies for humanoid robots in logistics and industrial operations.

At the same time, the ecosystem is expanding beyond traditional industrial automation players. Over the past two years, several additional technology companies have become increasingly relevant contributors to humanoid robotics development. These include semiconductor and computing companies, which are advancing high-performance AI chips and robotics compute architectures, as well as robotics-focused technology providers such as Unitree Robotics, Fourier Intelligence, Apptronik, and Figure AI, which are developing next-generation humanoid robot platforms.

As a result, the humanoid robotics ecosystem is evolving into a multi-layered technology landscape, where robot manufacturers, AI infrastructure providers, semiconductor companies, and industrial system integrators jointly drive innovation.

Partnership structures within this ecosystem are also evolving. Early collaborations were primarily focused on industrial pilot deployments, particularly in automotive and manufacturing environments. More recently, however, vendors have begun exploring broader commercial applications in logistics, retail, and potentially consumer-oriented markets. This shift indicates that humanoid robotics is gradually moving from experimental industrial pilots toward scalable commercial ecosystems.

Rapid Technological Progress in Humanoid Robot Capabilities

The most important driver behind the growing relevance of humanoid robotics is the visible improvement in robot capabilities. Compared with earlier generations, modern humanoid platforms demonstrate substantial progress in mobility, manipulation, perception, and task execution.

One major area of advancement is locomotion. Recent systems achieve stable bipedal walking, improved balance recovery, and dynamic motion control. While robots often still operate below human mobility levels in highly unstructured environments, the gap in structured industrial contexts has narrowed tremendously.

Another key improvement lies in manipulation capabilities. Modern humanoid robots are increasingly capable of handling objects, transporting materials, assisting in assembly processes, and performing inspection tasks. Advances in arm coordination, perception systems, and sensor integration allow robots to interact more reliably with real-world environments.

Equally important are improvements in perception and decision-making systems. The integration of machine learning models, multi-sensor fusion, and advanced computer vision enables robots to better understand their surroundings and adapt to dynamic conditions.

Source: 2026 NEXERY. humanoid market analysis

Simulation-based training and reinforcement learning further accelerate the development of robotic skills by allowing systems to learn complex behaviors in virtual environments before deployment.

Beyond these advancements, a central objective of many humanoid robotics developers is not only to match human capabilities but to exceed them – both in terms of performance and execution speed. This ambition reflects a shift from replicating human abilities toward optimizing them within a technical system.

In this context, humanoid robots offer a structural advantage: unlike human workers, they are not affected by fatigue, loss of concentration, or other human-related limitations. As a result, typical sources of error – such as mistakes caused by inattentiveness or physical exhaustion – can be greatly reduced or eliminated, leading to more consistent and reliable task execution.

These technological improvements are gradually narrowing the performance gap between humanoid robots and human workers in certain structured tasks. While humanoid systems are not yet capable of matching human versatility, they are increasingly able to perform repetitive physical tasks in controlled environments with growing reliability.

STATUS-QUO HUMANOID CAPABILITIES AND SPEED

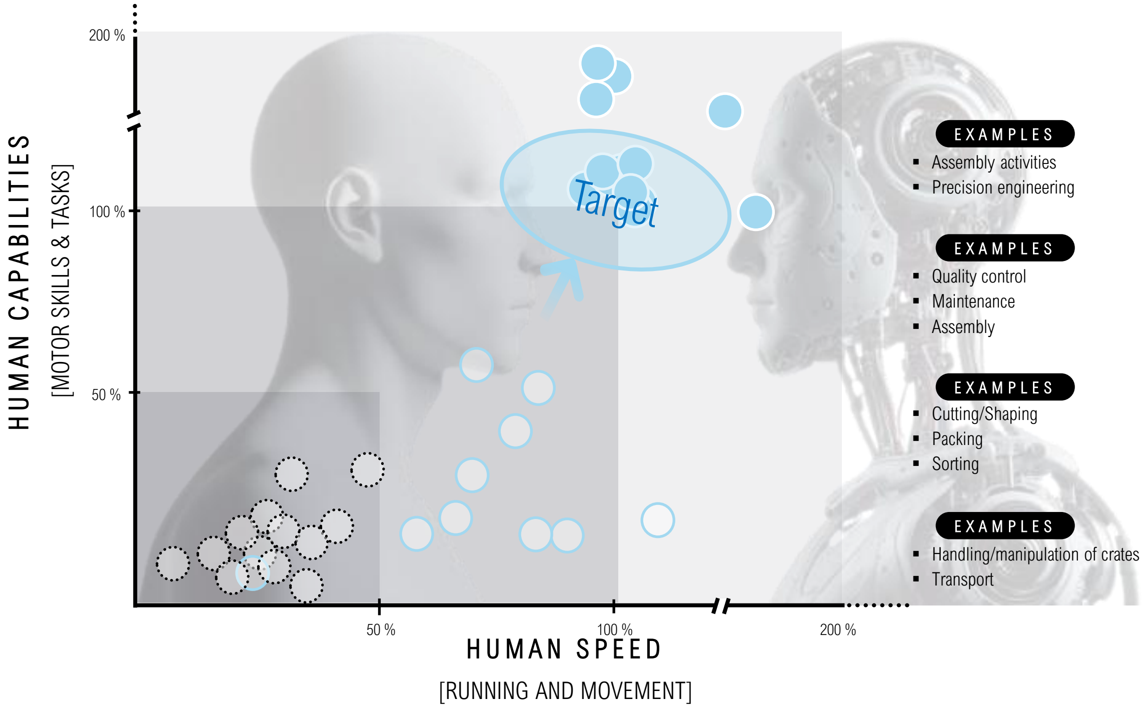


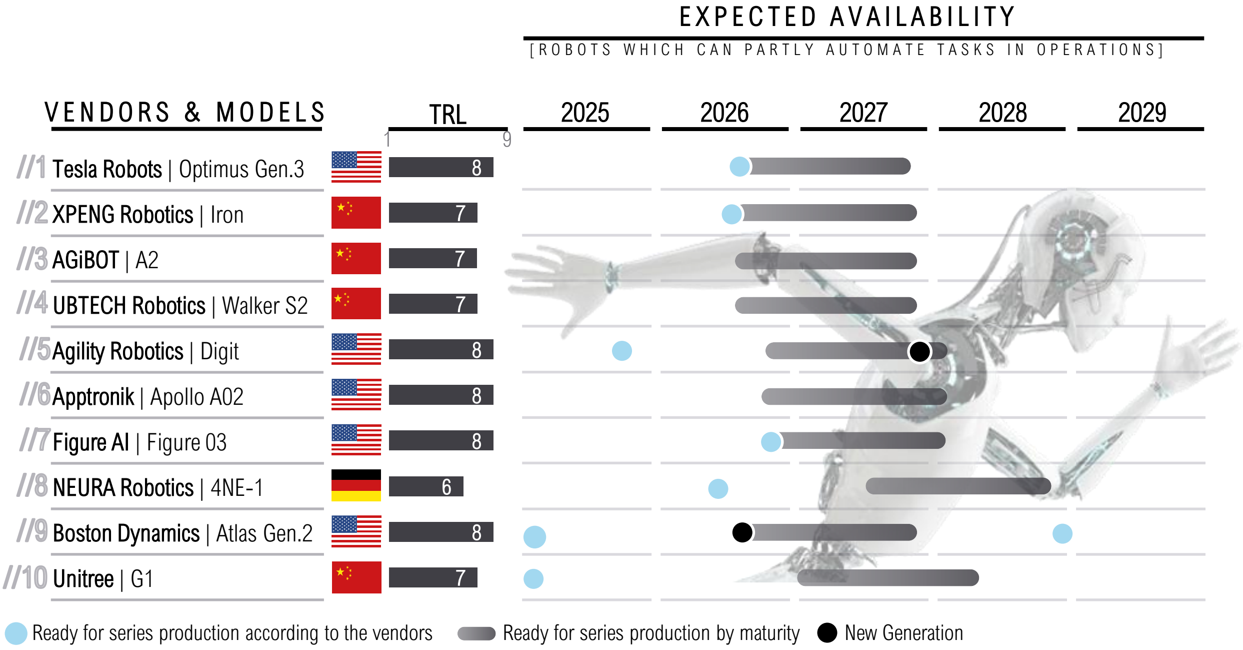
Fig 10: Excerpt humanoid robot development of human capabilities and speed based on an analysis of 90 commercial vendors

At the same time, many humanoid robots are steadily converging toward human-like capabilities across multiple dimensions of performance. However, an important trend in recent generations is not purely an increase in speed, but a shift toward greater autonomy and functional versatility.

In contrast to earlier systems – which often relied on teleoperation or pre-programmed sequences – newer humanoid platforms are increasingly capable of executing tasks independently within defined environments. This transition toward more autonomous operation is accompanied, in some cases, by a deliberate reduction in movement speed in order to improve stability, precision, and reliability in real-world applications.

Source: 2026 NEXERY. humanoid market analysis

As a result, current development trajectories suggest that the primary focus is moving away from maximizing raw performance metrics toward enabling robust, autonomous task execution. This shift is critical for industrial deployment, as the ability to perform a broader range of tasks independently often creates more value than higher execution speed under controlled conditions.



Notice: The Technical Readiness Level (TRL) indicates the maturity, from concept (1) to proven use in real production (9)

Fig 11: Excerpt from the assessment of the technological readiness levels of 10 manufacturers based on an analysis of 90 commercial vendors

Technology Readiness vs. Hype

The technological maturity of humanoid robots can be assessed through a combination of capability development, industrialization progress, and expected start-of-production timelines. While many vendors have demonstrated impressive prototypes, only a limited number currently appear ready to move toward early commercial production.

At the same time, the overall maturity of the ecosystem has progressed noticeably. Over the past year, nearly all major vendors have advanced by at least one level in terms of Technology Readiness Level (TRL), reflecting rapid development cycles and increasing system integration capabilities across the industry.

The most mature vendors combine advanced hardware capabilities with strong software stacks, pilot deployments with industrial partners, and credible manufacturing roadmaps. These companies are most likely to deliver the first commercially viable humanoid robot systems in the coming years.

However, maturity levels across vendors remain heterogeneous. Some companies focus primarily on industrial applications, while others explore consumer-oriented use cases or general-purpose platforms. As a result, the market is likely to evolve through multiple waves of commercialization rather than a single dominant breakthrough.

Source: 2026 NEXERY. humanoid market analysis

The first wave will likely consist of limited production deployments in structured industrial environments. Broader adoption across industries will follow once reliability improves, costs decrease, and deployment models become more standardized.

Remaining Technological and Organizational Challenges

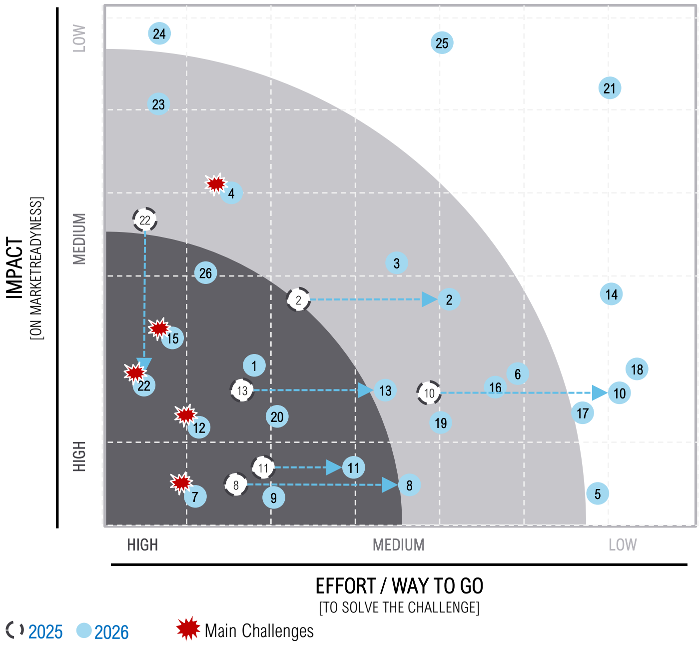
Despite the strong technological momentum, several challenges continue to limit the large-scale deployment of humanoid robots. These challenges can broadly be divided into technological barriers and organizational or industrial constraints, both of which are evolving dynamically as the technology matures.

Importantly, the nature of these challenges is not static. As certain technical limitations are gradually solved, new challenges emerge as systems become more complex and move closer to real-world deployment scenarios. This dynamic evolution reflects the transition of humanoid robotics from experimental prototypes toward industrial systems.

From a technological perspective, key challenges include reliable motor control, energy efficiency and battery life, robust object detection under real-world variability, and safe interaction with humans. Achieving stable and continuous operation under industrial conditions while maintaining system reliability remains a complex engineering task. In addition, thermal management and overheating of robotic systems are emerging as increasingly relevant challenges, particularly as higher computing performance, stronger actuators, and continuous operation requirements place growing demands on power and cooling architectures.

Beyond these technical aspects, organizational barriers also play a significant role in shaping the pace of adoption. Manufacturing cost, supply chain development, regulatory frameworks, safety standards, and the identification of economically viable use cases all influence how quickly humanoid robots can be deployed at scale. However, not all technological challenges are equally relevant for early market adoption.

VENDORS CHALLENGES



//TECHNOLOGICAL CHALLENGES [Hard- & Software]

1 Motor control
2 Battery life
3 Modularity
✸ 4 Precise movements (fine motor skills)
5 Compatibility of the systems
6 Detecting Objects
✸ 7 Autonomous learning & operating (Physical AI)
8 Humanlike communication
9 Complex problem solving
10 Mobility (walking speed <3 km/h)
11 Continuous operation
✸ 12 Safety in interacting with people
13 Flexibility in operation (Hardware)

//ORGANIZATIONAL CHALLENGES

14 Legislation and standards
✸ 15 Ramp-up of series production
16 Manufacturing cost
17 Financing
18 Identification of use cases
19 Expertise (software & hardware)
20 Industrialization
21 Partner mgmt.
✸ 22 Supply chain mgmt.
23 Supplier mgmt.
24 Service mgmt.
25 Sales
26 Privacy concerns

Fig 12: Overview of technological and organizational challenges in the development and manufacture of humanoid robots based on an analysis of 90 commercial vendors

Disclaimer: Challenges can vary per vendor as well as per location (e.g., due to applicable legislation)
Source: 2026 NEXERY. humanoid market analysis

Many industrial applications do not require fully autonomous robots or highly dexterous manipulation capabilities. Instead, the reliable execution of clearly defined tasks in structured environments is often sufficient to create economic value. As a result, successful vendors will focus on solving the most commercially relevant technological and operational challenges first, rather than attempting to immediately achieve full human-level capabilities.

Beyond the key challenge areas discussed in detail in the following sections, several additional technological and organizational constraints continue to shape the development of humanoid robotics.

These include, among others, system compatibility and integration into existing infrastructures, regulatory and standardization requirements, manufacturing scalability, as well as organizational capabilities such as partner management, supply chain development, and service operations.

In addition, the relevance and intensity of specific challenges vary significantly across vendors. Differences in technological approach, target markets, system architecture, and maturity levels lead to heterogeneous challenge profiles within the ecosystem. What represents a critical bottleneck for one vendor may already be partially solved for another.

To address these dynamics, many manufacturers are increasingly engaging in strategic partnerships across the ecosystem. Collaborations with technology providers, component suppliers, and industrial partners enable companies to externalize or accelerate the resolution of key challenges – particularly in areas such as AI development, hardware components, system integration, and industrial deployment. These partnership-driven approaches are becoming a central mechanism for reducing development risks and shortening time-to-market in an increasingly competitive landscape.

STATUS-QUO OF AUTONOMY IN WORKING AND LEARNING

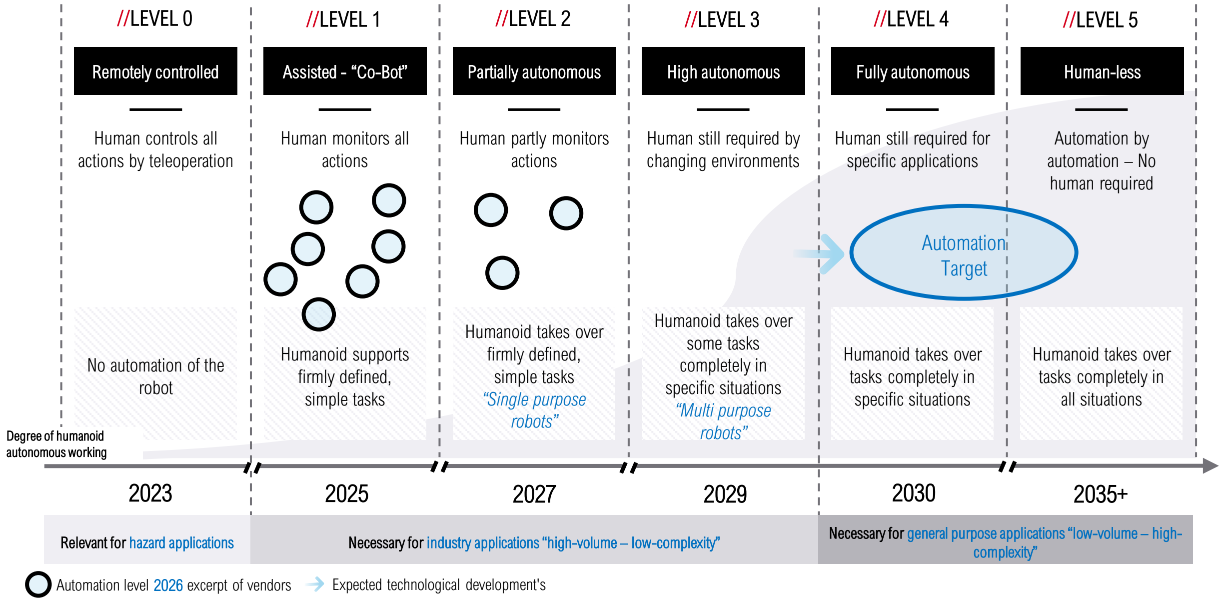


Fig 13: Expected development of the autonomy level of humanoid robots based on an analysis of 90 commercial vendors

Disclaimer: Challenges can vary per vendor as well as per location (e.g., due to applicable legislation)

Source: 2026 NEXERY. humanoid market analysis

Challenges of Autonomy in Working and Learning

Autonomy is one of the most frequently discussed aspects of humanoid robotics. However, full autonomy across all situations is not a prerequisite for most industrial applications.

In practice, humanoid robots can operate at different levels of autonomy. Lower levels rely heavily on remote control or scripted behavior, while intermediate levels allow robots to execute tasks autonomously within structured environments under human supervision. The highest levels correspond to fully autonomous operation across unpredictable environments.

For industrial applications such as logistics, assembly, or warehouse operations, intermediate autonomy levels are often sufficient. Robots can perform specific tasks independently while human operators remain responsible for exception handling or system supervision.

This staged autonomy model allows humanoid robots to deliver value before reaching full human-like autonomy. As a result, commercial deployment is likely to expand gradually, beginning with structured industrial environments where autonomy requirements are more manageable.

Challenges in Safe Human–Robot Interaction

Safe human-robot interaction is another important aspect of humanoid robot deployment. Contrary to common perception, however, safety challenges can often be addressed using established industrial robotics concepts.

STATUS-QUO IN SAFE HUMAN–ROBOT INTERACTION

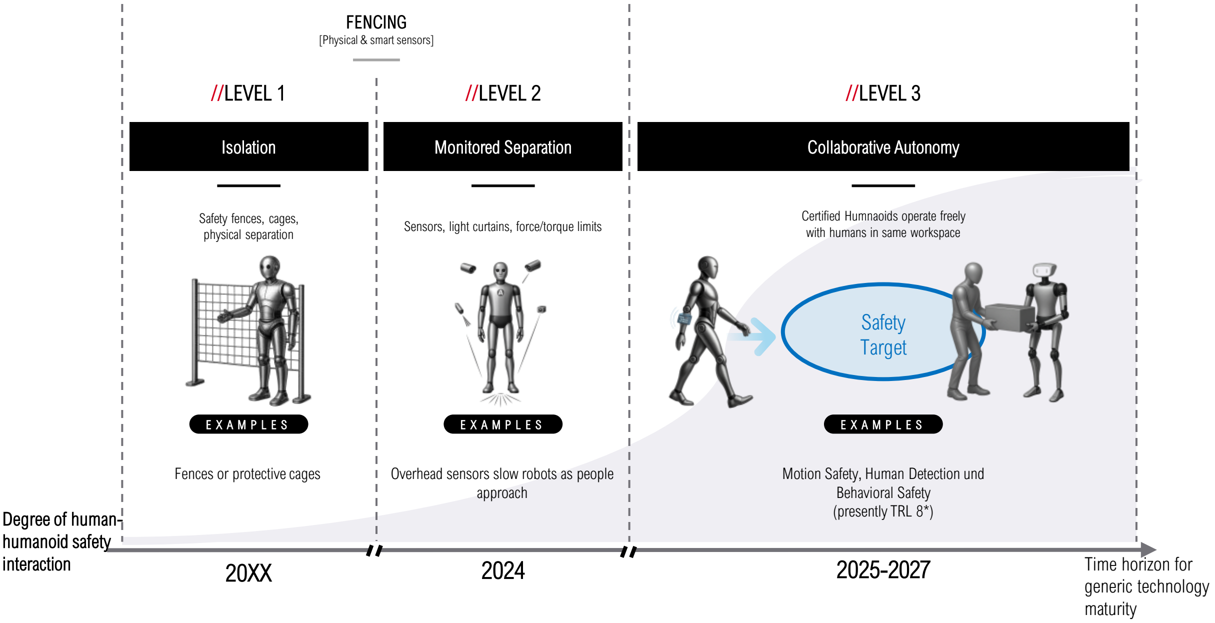


Fig 14: Expected development of safe interaction between humanoid robots and humans

Disclaimer: Challenges can vary per vendor as well as per location (e.g., due to applicable legislation)

Source: 2026 NEXERY. humanoid market analysis

Many early humanoid applications will rely on controlled environments where robots operate within clearly defined safety zones. Techniques such as fencing, monitored separation, and speed limitations already provide proven methods for ensuring safe collaboration between humans and robots.

As technology evolves, more advanced interaction models may allow robots to operate more freely alongside humans. However, even with existing safety mechanisms, many industrial use cases can already be implemented without major technological breakthroughs.

Therefore, safety should be viewed less as a fundamental barrier and more as an engineering and system-integration challenge that can be addressed through appropriate design and risk management.

Challenges of Motor Skills and Dexterous Manipulation

Motor skills and manipulation capabilities represent one of the most important technological frontiers in humanoid robotics.
While locomotion has improved significantly in recent years, the ability to manipulate objects with human-like dexterity remains challenging.

Current humanoid systems typically rely on different levels of hand complexity. Basic grippers are sufficient for handling larger objects or containers, while multi-finger hands allow more flexible grasping and manipulation. Fully dexterous five-finger hands aim to replicate human hand functionality but require highly advanced control algorithms and sensor feedback.

The complexity of dexterous manipulation arises not only from mechanical design but also from the need for precise coordination between perception, force control, and finger movement. Reliable manipulation therefore requires sophisticated software as well as advanced hardware.

STATUS-QUO OF MOTOR SKILLS AND DEXTEROUS MANIPULATION

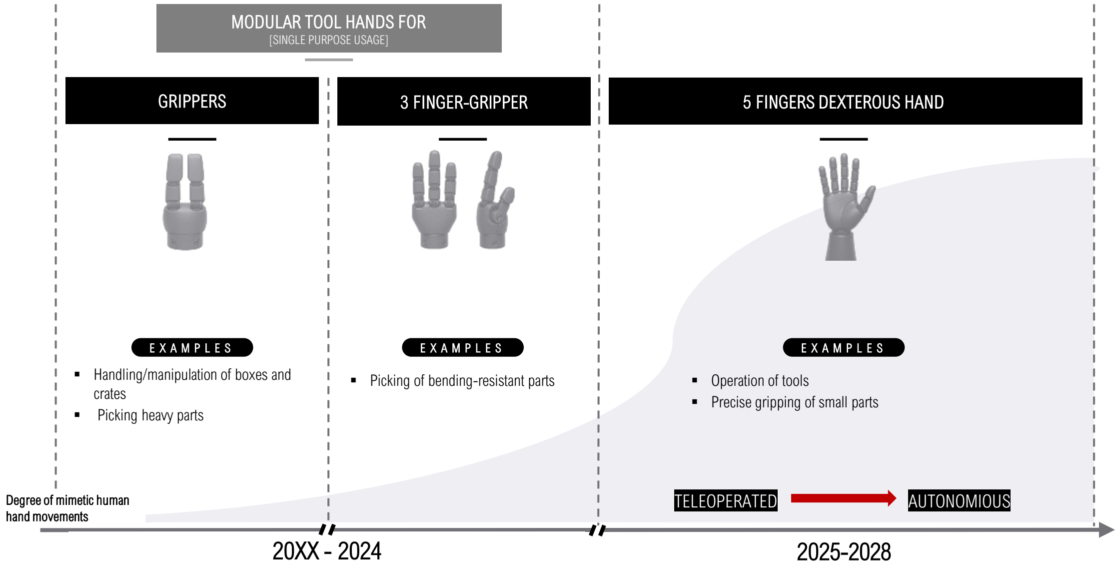


Fig 15: Expected development of the motor skills of humanoid robots

Disclaimer: Challenges can vary per vendor as well as per location (e.g., due to applicable legislation)
Source: 2026 NEXERY. humanoid market analysis

As humanoid robots move toward more complex industrial tasks, improvements in motor skills will become more important. Vendors that successfully combine mechanical dexterity with intelligent control systems are likely to gain a significant competitive advantage.

A common assumption in humanoid robotics is that systems should replicate human anatomy as closely as possible – particularly in the design of hands. However, for industrial applications, a fully human-like hand is not necessarily the optimal solution. Instead, task-specific and modular end-effectors often provide significantly higher efficiency, reliability, and performance.

Industrial environments typically require a wide range of manipulation tasks, from handling standardized components to performing repetitive assembly or transport activities. In such contexts, specialized grippers or interchangeable tool modules can outperform anthropomorphic hands by offering greater precision, robustness, and ease of control. Modular hand systems that can be adapted or replaced depending on the use case enable a higher degree of flexibility while reducing system complexity and maintenance requirements.

Beyond end-effectors, the overall physical design of humanoid robots does not need to strictly follow human morphology to create value. In fact, deviations from the human form can unlock additional performance advantages. For example, robots equipped with multiple arms or additional manipulation units can execute parallel tasks, increase throughput, and operate more efficiently in constrained industrial environments.

This highlights a key principle for industrial humanoid robotics: functionality should take precedence over anthropomorphism. While human-like design can facilitate interaction in certain scenarios, the highest economic value in industrial applications is achieved when robot design is optimized for task performance rather than for mimicking human anatomy.

Disclaimer: Challenges can vary per vendor as well as per location (e.g., due to applicable legislation)

Source: 2026 NEXERY. humanoid market analysis

//05 Technology Costs

As humanoid robotics moves from prototypes toward early commercial deployment, cost becomes a key factor for large-scale adoption. Understanding the cost structure of humanoid systems and the expected cost trajectory is therefore essential for assessing the economic viability of both industrial and household robots.

Cost Structure of Humanoid Robots

The cost of humanoid robots is largely driven by the combination of advanced hardware components and the software systems required to operate them. Key cost elements include actuators and motors for movement, sensor systems for perception, on-board computing hardware, and AI-based control software. In particular, the mechanical architecture – comprising motors, transmissions, and precision servo systems across multiple degrees of freedom – represents a substantial share of the overall cost.

Additional cost drivers include perception technologies such as cameras and depth sensors as well as high-performance computing chips that process sensor data and control robot motion. Software and AI systems further contribute to development costs, although their marginal cost per robot decreases as production volumes increase.

Overall, the current cost level of humanoid robots is still strongly influenced by the early stage of industrialization. Large-scale production and standardized supply chains are only beginning to emerge – meaning that significant scale effects have yet to materialize. As production volumes increase and component ecosystems mature, these scale effects are expected to reduce unit costs greatly. In general, the broader the functional capabilities of a humanoid robot – such as higher degrees of freedom, advanced manipulation, or autonomy – the higher the resulting system cost.

Cost Outlook for Industrial Humanoid Robots

Future cost developments will differ between industrial and household humanoid robots, as both segments follow different economic logics and functional requirements.

Industrial humanoid robots are expected to remain more complex and therefore more expensive, as they require higher payload capacities, robust industrial components, and advanced safety and reliability standards for operation in production environments.
With increasing standardization and larger production volumes, manufacturing costs for industrial humanoid robots could decline to roughly $55,000 per unit over the coming years – enabling broader adoption across industrial use cases.

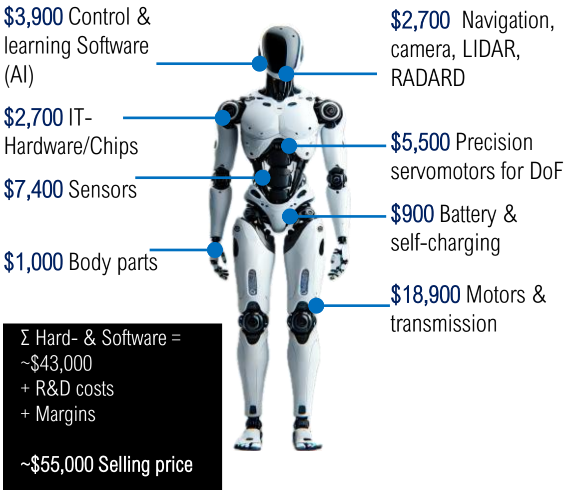


Fig 16: Estimated Selling Price for Humanoid Robots broken down into hard- and software components

Source: 2026 NEXERY. humanoid market analysis

Household humanoid robots, by contrast, are likely to follow a consumer-electronics cost trajectory. These systems typically require lower payload capacities and less demanding industrial specifications, allowing for simpler hardware architectures and therefore lower price points. As a result, household humanoid robots are expected to become significantly cheaper than industrial systems over time – particularly as consumer-scale electronics supply chains, standardized components, and high production volumes emerge.

Across both segments, production scale will be the most important driver of cost reduction. As manufacturing processes mature and component costs decline, humanoid robots are expected to become more affordable and economically viable for a wider range of industrial and consumer applications.

In addition to traditional upfront purchase models, alternative commercial models for humanoid robotics are becoming particularly relevant. Instead of acquiring robots as capital assets, companies and end users can access robotic capabilities through more flexible pricing structures such as pay-per-hour, pay-per-task, or subscription-based ("Robot-as-a-Service") models.

These approaches significantly lower the initial investment barrier and shift costs from capital expenditure (CapEx) to operational expenditure (OpEx), making adoption more accessible – especially for companies that prefer to test the technology through pilot deployments before scaling. At the same time, such models enable greater flexibility, as pricing can be aligned with actual usage and performance outcomes.

From a vendor's perspective, recurring revenue models enable closer customer relationships, continuous system updates, and integrated service offerings. These offerings include maintenance, software upgrades, and performance optimization. As the market matures, these flexible commercial models are likely to play a key role in accelerating the adoption and scaling of humanoid robotics across industries.

Source: 2026 NEXERY. humanoid market analysis

//06 Potential and Challenges for Companies

As humanoid robotics is increasingly moving toward a practical tool for industrial automation, the key question for companies is no longer whether the technology will emerge, but where it can create tangible operational value. The following section outlines the most relevant application areas and the potential impact of humanoid robots across industrial environments.

Application Landscape of Humanoid Robotics

Humanoid robots are designed as general-purpose robotic systems, capable of operating in environments originally built for human workers. As a result, their potential application landscape spans a wide range of sectors, including healthcare, education, service industries, entertainment, household assistance, and research.

However, in the near future, the industrial sector is expected to become the primary adoption environment. Production facilities, logistics operations, and maintenance environments provide structured workflows where humanoid robots can support repetitive physical tasks, assist human workers, and operate existing equipment designed for human use.

Within industry, humanoid robots are particularly suited for tasks such as material handling, internal logistics, production assistance, inspection activities, and support for manual assembly processes. Because these environments often combine repetitive tasks with a need for flexibility, humanoid robots can complement traditional automation technologies that are typically optimized for highly standardized processes.

Overall, while the long-term application landscape of humanoid robotics extends across many sectors, industrial environments are expected to represent the first large-scale deployment market.

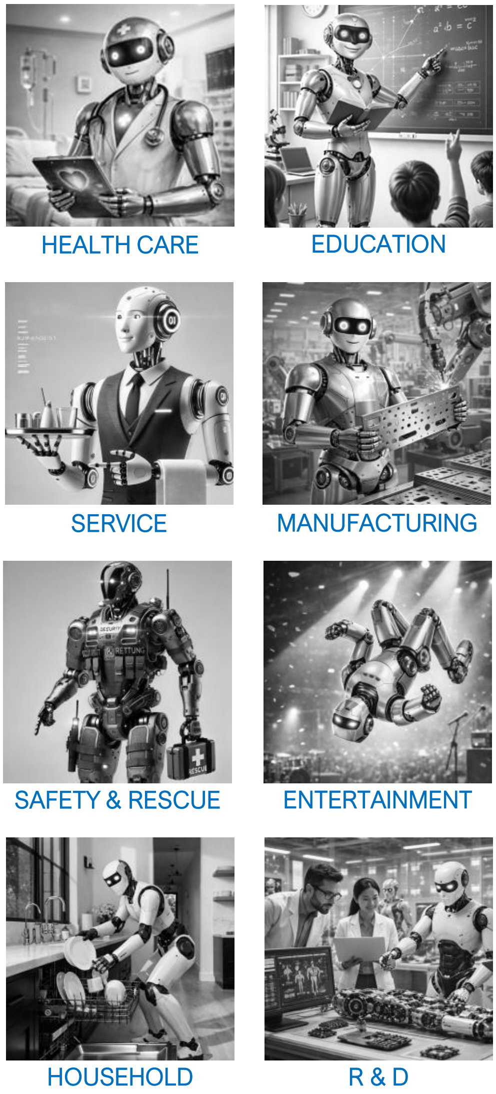


Fig 17: Overview of Humanoid Robotics Applications

Industrial Value Potential

From a corporate perspective, the economic potential of humanoid robotics lies in automating physical tasks that are currently performed manually but are difficult to automate using traditional industrial robots.

Many industrial operations still rely on human labor for activities such as material transport, sorting, manual assembly support, equipment operation, or visual inspection. These tasks often take place in environments that require flexibility, mobility, and interaction with tools and infrastructure designed for humans.

The feasibility of automation strongly depends on the degree of repetition and process standardization. The more repetitive and structured a task is, the easier it becomes to automate it with humanoid robots. Activities such as material handling, internal logistics, or repetitive production support are therefore particularly suitable for early deployments.

In several industrial scenarios, particularly in production support and logistics, automation potentials of more than 40% of current manual tasks are considered achievable. Importantly, humanoid robots are expected to complement rather than replace traditional automation, filling the gap between human labor and highly specialized industrial machines.

To illustrate this potential in practice, several industry cases highlight where companies could benefit most from humanoid robotics adoption:

CASE 1 - Automotive OEM

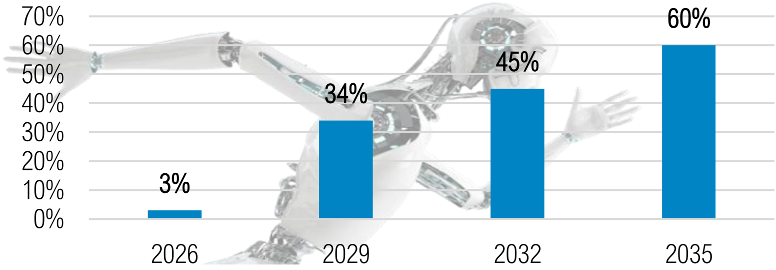


Fig 18: Project-Case 1 – Potential of humanoids taking over tasks in a Automotive OEM over the next 10 years | Additional potential based on an automation level of ~49%

CASE 2 - Semiconductor Company

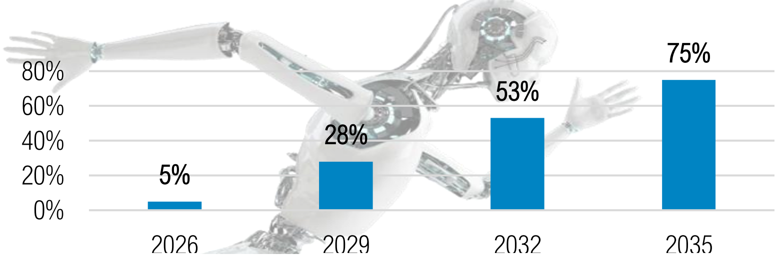


Fig 19: Project-Case 2 – Potential of humanoids taking over tasks in a Semiconductor Company over the next 10 years | Additional potential based on an automation level of ~79%

Source: 2026 NEXERY. humanoid market analysis

CASE 3 - Contract Manufacturing Company

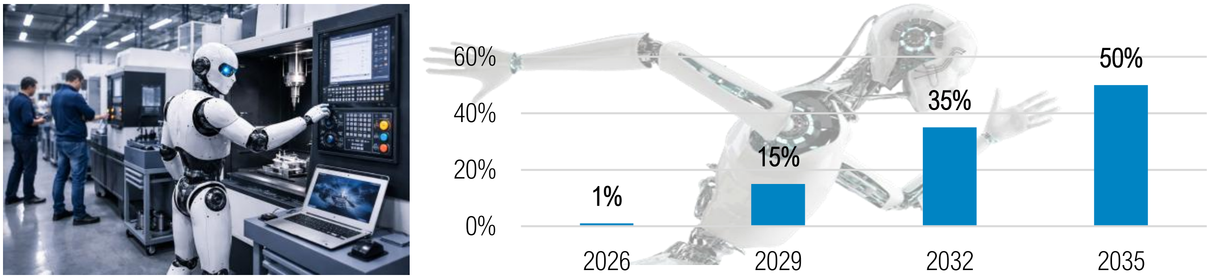


Fig 20: Project-Case 3 – Potential of humanoids taking over tasks in a Contract Manufacturing Company over the next 10 years | Additional potential bases on an automation level of ~8%

The industry scenarios shown are based on concrete projects, developed jointly with industry companies. The objective of these engagements was to assess – grounded in real process environments – how much automation and value-creation potential humanoid systems can unlock in the respective companies over the coming years. The trajectories should therefore be read as project-based potential estimates derived from real-world contexts. At the same time, they remain conditional on explicit assumptions, for example the expected pace of technology maturation, integration feasibility, ramp-up speed, and scaling capacity – rather than being guaranteed outcomes.

A consistent finding across projects is the strong link between process maturity and humanoid potential: the more standardized, transparently specified, and disruption-free the processes are, the higher the identified automation potential. In terms of the "Dimensions of Robot Analysis," the highest potential typically appears where work is executed via uniform procedures, where execution runs smoothly without visible delays or errors, and where the system delivers consistent output quality cycle after cycle. In these environments, humanoid robotics benefits from reduced integration complexity – clearer task logic, more stable safety concepts, and cleaner interfaces to upstream and downstream systems – making it easier to move toward scalable operating models.

EVALUATION DIMENSIONS

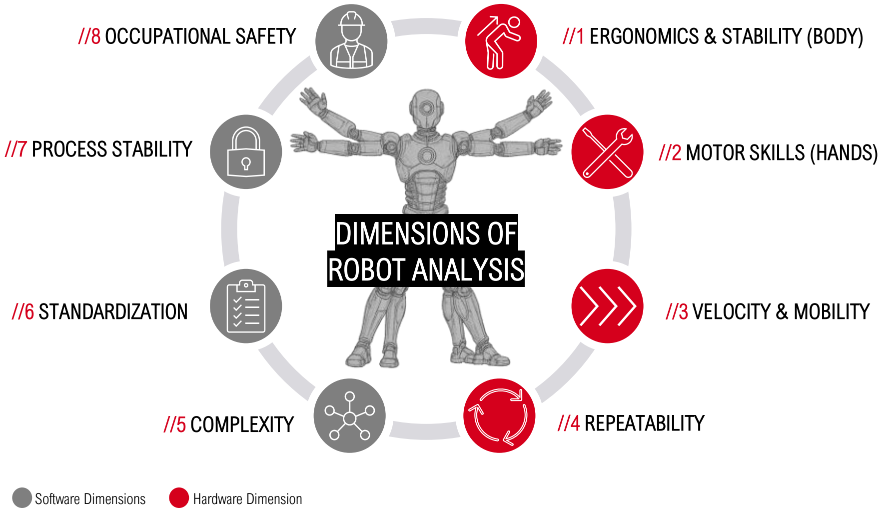


Fig 21: Dimensions, to evaluate humanoid robots for their current and future expected capabilities.

Source: 2026 NEXERY. humanoid market analysis

A second, highly operational insight emerged from the project work: even in settings perceived as highly standardized, substantial parts of the actual process execution were not sufficiently documented or explicitly described. Typical gaps included exception handling, informal workarounds, and tacit expert knowledge that was never captured in standard operating procedures. As a result, the analyses uncovered a range of inefficiencies and recurring disruptions that do not primarily require humanoid automation but can often be addressed through classical problem-solving approaches. Examples include root-cause analysis methods such as 5-Why, establishment of standard work, clarification of handover points and responsibilities across interfaces, error-proofing and quality-at-the-source measures, as well as stabilization of material provision and process flows.

This is strategically relevant in two ways: it enables near-term performance improvements through process stabilization, and it materially increases automation readiness, which in turn accelerates the later scaling of humanoid systems.

A further insight from the cases is that many use cases do not actually require bipedal humanoids. In numerous situations, the critical value driver is not “two legs,” but the ability to manipulate objects and tools, navigate structured environments, and integrate reliably into shopfloor operations. Consequently, alternative embodiments – such as mobile manipulators on wheels, AMRs with arms, or fixed-base collaborative robots – can be more practical, safer, and cost-effective for a significant share of identified applications. This underlines the importance of selecting the robot form factor based on the task environment and operational constraints, rather than defaulting to a bipedal design.

Overall, the cases point to a robust pattern: humanoid robotics is currently less a “plug-and-play” technology topic and more a consequence of process readiness. Organizations that systematically improve their operations along the underlying dimensions – standardization, stability, repeatability, and manageable variability – achieve immediate performance gains while also creating the structural prerequisites to industrialize humanoid systems economically, safely, and at scale in the coming years.

Implementation Challenges in Industrial Environments

Deploying humanoid robots in real production environments introduces a variety of operational challenges. Unlike traditional industrial automation, humanoid robots must be integrated into existing human-centric environments, where processes, tools, and infrastructure were originally designed for manual work.

A challenge is the identification of suitable pilot use cases. Not all tasks are equally suited for humanoid automation. Companies must evaluate where robots can generate value, considering factors such as task repetition, process stability, safety requirements, and integration with existing workflows.

In addition, implementation requires alignment across several operational dimensions – see figure 21. Process stability, system reliability, safety requirements, and integration with existing IT and automation systems all influence how quickly humanoid robots can be deployed. Organizations must also develop internal capabilities in areas such as robotics integration, operation, and maintenance.

For this reason, many companies initially focus on clearly defined pilot projects, allowing them to test the technology, build operational experience, and gradually expand deployment across additional use cases.

Source: 2026 NEXERY. humanoid market analysis

IMPLEMENTATION CHALLENGES

//STRATEGY & PERFORMANCE

- 1 Humanoid Strategy
- 2 Economics of the technology
- 3 Change in the operating model
- 4 Identification of partner model

//PROCESSES

- 5 Identification of use cases
- 6 Identification of vendors
- 7 Complex processes
- 8 Process repeatability
- 9 Scalability / Rollout
- 10 Further development of the process model*
- 11 Low process stability
- 12 Low process standardization

//GOVERNANCE & STRUCTURES

- 13 Works councils – employers' associations
- 14 Privacy
- 15 Resistance in the company
- 16 Standards and certification

//RESSOURCES & CAPABILITIES

- 17 Technology know-how
- 18 Capacity building
- 19 Financial resources
- 20 Change in work culture

//SYSTEMS & TECHNOLOGY

- 21 Security of technology
- 22 Reliability and robustness
- 23 Digitization
- 24 Integration with existing systems

Fig 22: Overview of challenges Humanoid Piloting & Implementation based on an analysis of >12 project

Vendor Partnering

One of the most critical challenges in early humanoid robot adoption is the identification of suitable technology partners. The humanoid robotics ecosystem is still highly fragmented, with a large number of vendors operating at different levels of technological maturity.

Most robot platforms are still evolving, and fully standardized off-the-shelf solutions are rare. As a result, companies typically cannot rely on traditional procurement models. Instead, successful implementations often require close collaboration with vendors through joint pilot or development projects. Selecting the right partner therefore requires evaluating not only the robot platform itself but also the vendor's technology roadmap, software architecture, integration capabilities, and long-term scalability.

In many cases, companies must build a broader partner ecosystem that includes robotics vendors, software providers, and system integrators.

Process Adaptation and Development

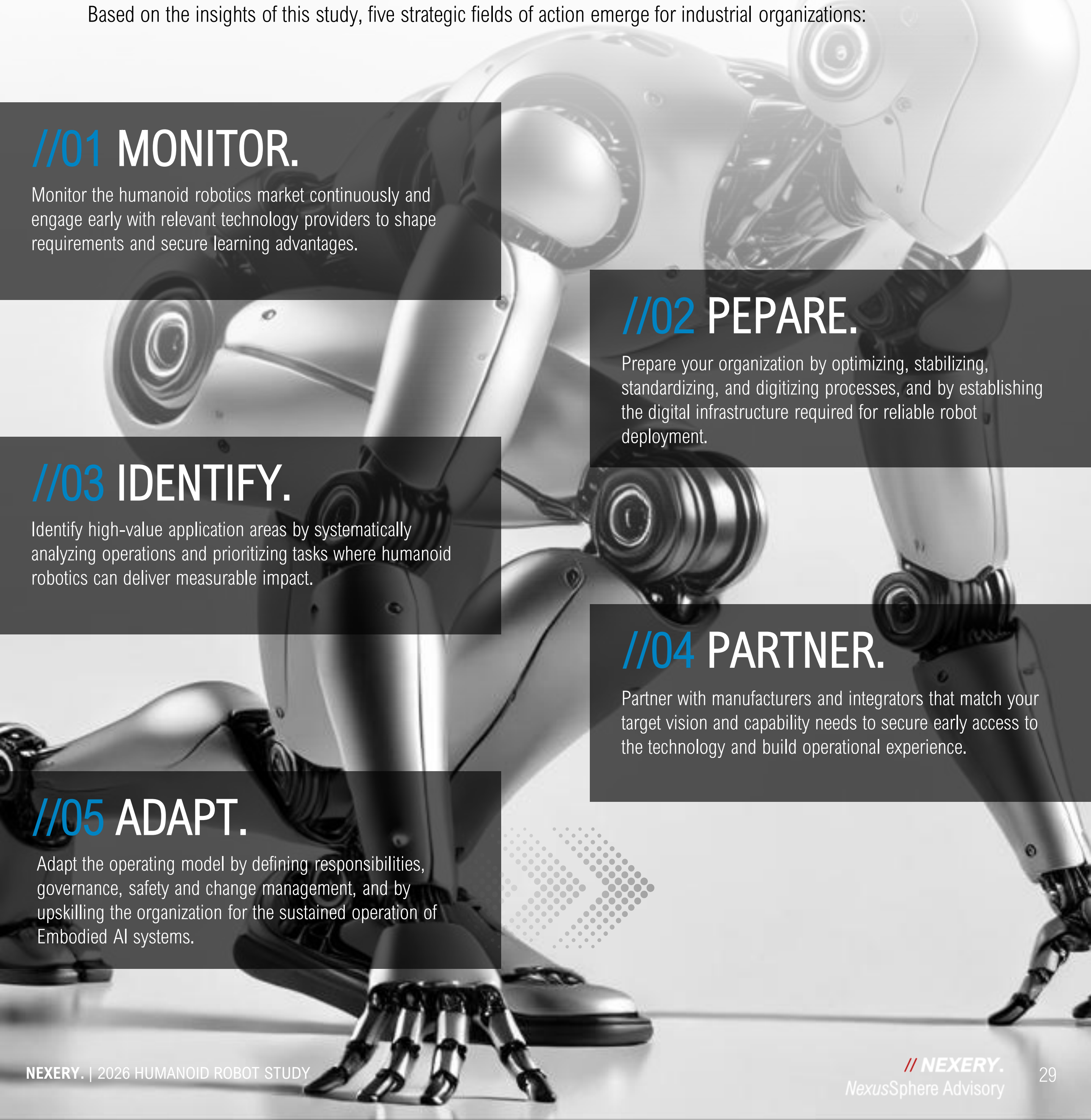
In addition to vendor selection, process adaptation plays a decisive role in the successful implementation of humanoid robots. Many existing industrial processes have been optimized either for human workers or for specialized automation systems. However, humanoid robots possess a different set of strengths and limitations. Companies can therefore significantly accelerate deployment by redesigning processes to better match the capabilities of humanoid robots. Instead of replicating existing human workflows exactly, tasks can be reorganized, simplified, or redistributed to create robot-friendly process structures. This approach can substantially improve scalability. When processes are designed with robotic capabilities in mind, humanoid systems can often be deployed faster and across a broader range of operations than when they are integrated into unchanged workflows. Consequently, companies that actively adapt and redesign their operational processes are likely to achieve more rapid and larger-scale adoption of humanoid robotics.

Source: 2026 NEXERY. humanoid market analysis

//07 Way-Forward

After reviewing the technological progress, market development, and industrial potential of humanoid robotics, a key question remains:
What actions should companies take today?

The technology is still emerging - humanoid robots are expected to play an increasing role in industrial automation. Based on the insights of this study, five strategic fields of action emerge for industrial organizations:



//01 MONITOR.

Monitor the humanoid robotics market continuously and engage early with relevant technology providers to shape requirements and secure learning advantages.

//02 PEPARE.

Prepare your organization by optimizing, stabilizing, standardizing, and digitizing processes, and by establishing the digital infrastructure required for reliable robot deployment.

//03 IDENTIFY.

Identify high-value application areas by systematically analyzing operations and prioritizing tasks where humanoid robotics can deliver measurable impact.

//04 PARTNER.

Partner with manufacturers and integrators that match your target vision and capability needs to secure early access to the technology and build operational experience.

//05 ADAPT.

Adapt the operating model by defining responsibilities, governance, safety and change management, and by upskilling the organization for the sustained operation of Embodied AI systems.

// IMPRINT

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Munich, April 2026