From Technological Innovation to Commercialization Building Competitive Advantage in a Robotics Firm: A Case Study of Unitree Robotics

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Abstract

This study examines how a robotics manufacturer converts technological resources into commercialization and competitive positioning. Using a longitudinal, embedded single-case design based on public documentary evidence, it analyzes Unitree Robotics' quadruped and humanoid robot businesses from August 26th, 2016 - the company's incorporation date, to September 30th, 2026. The analysis combines the resource-based view, dynamic capabilities theory and innovation-commercialization research to examine technological resources, product diversification, manufacturing organization, sales channels and financial outcomes. The evidence indicates substantial revenue growth, a marked shift toward humanoid robots and hybrid production and channel configuration. However, 2026 interim results show that revenue growth coexisted with declines in adjusted net profit and operating cash flow. Public information remains insufficient to establish repeat customer demand, routine industrial deployment or superior unit economics. The study argues that Unitree has developed a significantly emerging commercial position, while the sustainability of its competitive advantage remains conditional on reliable applications, recurring customer value, profitability and cash generation.

Keywords

Unitree Robotics, Technological innovation, Commercialization, Dynamic capabilities, Competitive advantage

Introduction

Background and research problem

Robotics is moving beyond fixed industrial automation. Advances in actuation, sensing, motion control, embedded computing and artificial intelligence have widened the range of tasks robots may perform. Yet technical progress does not automatically create commercial value. A manufacturer must convert engineering knowledge into products, organize production, reach customers and support reliable use. The returns from innovation therefore depend not only on invention but also on complementary assets such as manufacturing, distribution and service.

Unitree Robotics is a useful case for examining this conversion process. The company develops quadruped and humanoid robots and related components. Its prospectus reports operating revenue of Renminbi (RMB) 159.13 million in 2023, RMB 392.77 million in 2024 and RMB 1,699.27 million in 2025. In 2025, humanoid robots accounted for 51.78% of main-business revenue and quadruped robots for 41.62%, compared with 1.88% and 75.78%, respectively, in 2023. These figures indicate rapid expansion and a substantial product-mix shift; they do not, by themselves, establish sustainable competitive advantage.

The 2026 third-quarter report presents a more complex picture. In the first nine months of 2026, revenue increased 55.71% year on year and net profit attributable to shareholders increased 270.54%. However, net profit excluding non-recurring items declined 18.78%, while operating cash flow declined 54.69%. Research and development (R&D) expenditure increased 191.48%. These results make it necessary to distinguish revenue growth from recurring profitability and cash generation. The interim report is unaudited and is analyzed separately from audited annual results.

manufacturers convert problem is how a robotics manufacturer converts technological resources into commercial outcomes and under what conditions those

outcomes may support competitive advantage. The resource-based view explains how firm resources may underpin advantage, while dynamic capabilities theory examines how firms build and reconfigure competences as technologies and markets change. Commercialization research emphasizes complementary assets and business-model arrangements through which firms create, deliver and capture value.

Research questions and objectives

This study addresses three questions: (1) How do Unitree's disclosed technological and organizational resources support product innovation? (2) Through what commercialization mechanisms does the company translate innovation into market performance? (3) To what extent do the observed outcomes indicate competitive advantage, and what constraints affect its sustainability?

This study has several objectives: First, it identifies resources disclosed by the company. Second, it reconstructs the development trajectory of its quadruped robot and humanoid robot product businesses. Third, it examines the firm's manufacturing layout, distribution channels, and application positioning. Finally, it assesses revenue, profit margins, R&D investment, profitability and cash flow. It also considers the limitations of available evidence regarding customers and real-world deployments.

Scope and significance

The case is Unitree Robotics Co., Ltd. The historical reconstruction covers 2016 to the third quarter of 2026, subject to dated public evidence. Audited annual comparisons focus on 2023-2025; 2026 interim figures are reported separately. The embedded analytical units are quadruped robots, humanoid robots and robotic components. The study uses public documents only and does not assume interviews, questionnaires or proprietary internal data.

The study contributes a producer-side analysis to a literature in which many empirical robotics studies examine firms adopting robots rather than firms manufacturing them. Its aim is analytical explanation, not statistical generalization.

Literature review and theoretical framework

Resources, innovation and capability renewal

The resource-based view explains performance differences through firm-specific resources. Barney argues that resources can support sustained advantage when they are valuable, rare, difficult to imitate and non-substitutable [2]. For a robotics manufacturer, candidate resources include component designs, control algorithms, engineering know-how, intellectual property, manufacturing routines and accumulated product-development experience. These are analytical candidates: Company claims about technical capability do not establish rarity or inimitability without competitor and customer evidence.

Technological development is cumulative and path dependent. Dosi describes technological paradigms and trajectories, while Danneels shows how product innovation both draws on and renews technological and customer competences [3,4]. Absorptive capacity concerns a firm's ability to recognize, assimilate and apply external knowledge. Zahra and George distinguish potential from realized absorptive capacity [5]. These concepts help interpret technical learning and external collaboration, but public code or developer resources alone do not prove effective knowledge absorption.

Dynamic capabilities

Teece, Pisano and Shuen define dynamic capabilities through the integration, building and reconfiguration of competences [6]. Teece elaborates sensing, seizing and transforming as dimensions of capability renewal [7]. These categories structure the analysis. Sensing refers to the recognition of technological and market opportunities. Seizing covers resource commitments and commercialization choices. Transforming involves changes to product portfolios, technologies, and organizational arrangements.

Dynamic capabilities must be grounded in identifiable processes. Eisenhardt and Martin discuss processes such as product development and strategic decision-making [8]. Winter distinguishes dynamic capabilities from ordinary operating routines [9]. Helfat and Peteraf examine capability lifecycles [10]. Accordingly, successful product launches are not automatically treated as proof of dynamic capabilities. The analysis requires observable evidence of adaptation and considers alternative explanations.

Commercialization, business models and ecosystems

Teece emphasizes complementary assets - including manufacturing, distribution and service - in capturing value from innovation [11]. Chesbrough and

Rosenbloom explain how business models connect technological potential to economic value [12]. Teece frames business models through value creation, delivery and capture, while Zott and Amit conceptualize them as systems of interdependent activities [13,14]. Baden-Fuller and Haefliger further explain the mediating relationship between technology, business models and performance [15].

Platform and ecosystem perspectives clarify the distinction between internal technical reuse and external complementarity. Gawer and Cusumano distinguish internal product platforms from external industry platforms [16]. Adner treats an ecosystem as an alignment structure among actors required for a value proposition [17].

A software development kit or public repository may facilitate experimentation, but it is not sufficient evidence of an active commercial ecosystem.

Research on industrial robots-as-a-service identifies adoption barriers such as initial investment, total cost of ownership, programming expertise and safety. This is adjacent sector literature only; this study does not assume that Unitree operates a robot-as-a-service model.

Research gap and analytical framework

The literature explains resource heterogeneity, capability renewal, complementary assets, business-model design and ecosystem coordination. This study connects these perspectives in a producer-side case of a robotics firm with multiple product categories and disclosed commercial and financial information. The contribution is not a claim that robotics commercialization has been ignored, but an examination of how the mechanisms interact in one firm.

The framework has four layers: (1) Resource base - technology, people, intellectual property and organizational knowledge. (2) Dynamic capabilities - sensing, seizing and transforming. (3) Commercialization mechanisms - product development, manufacturing and sourcing, channels, applications and developer-facing resources. (4) Outcomes - sales, revenue mix, margins, R&D, profit and cash flow. Competition, maturity, customer adoption, supply-chain dependence and regulation are treated as constraints.

Four propositions guide the analysis: P1: Integration of components, motion control and system engineering may support product diversification. P2: A combination of internal control and external sourcing may support manufacturing flexibility, although cost effects require evidence. P3: Differentiated channels and developer resources may improve market access, but do not alone prove customer value or ecosystem strength. P4: Sustainable advantage requires more than revenue growth. It also depends on recurring profitability, cash conversion, reliable applications and repeat demand. These propositions organize case interpretation and are not statistical hypotheses.

Research methodology

Design and case selection

This study adopts a longitudinal, embedded single-case design based on public documentary evidence. Case-study research is appropriate for examining contemporary processes in their real-world context. Eisenhardt emphasizes alignment among research questions, evidence and constructs [18]. Flyvbjerg explains the value and limits of case-based knowledge. Unitree is selected purposively because its public disclosures provide information on product categories, sales, financial performance, R&D, channels and risks [19]. The design supports analytical rather than statistical generalization.

Period, sources and evidence assessment

The historical reconstruction ranges from August 26th, 2016 - the company's incorporation date, to September 30th, 2026. Audited annual data cover 2023-2025, while the 2026 third-quarter report is unaudited. Data sources fall into several groups. The first group comprises the initial public offering (IPO) prospectus, listing documents, and quarterly reports. The second includes corporate products and technical materials. The third covers government policy documents. The fourth consists of independent industry research. The last group is peer-reviewed literature.

Each document is recorded with source identifier (ID), issuing organization, date, uniform resource locator (URL), relevant page or section, factual content, analytical relevance and limitations. Following Bowen, documents are assessed for authenticity, credibility, representativeness and meaning [20]. Regulatory filings are authoritative evidence of what the company disclosed, but company statements about technical superiority still require independent corroboration. Production, shipment, sales, delivery, customer acceptance and revenue

recognition are kept distinct.

Analysis, validity, and limitations

Four analytical procedures are adopted. The first is chronological reconstruction. The second is thematic coding covering resources, dynamic capabilities, commercialization, and constraints. The third involves a comparison of the three product units embedded. The fourth is descriptive analysis of sales, product mix, prices, margins, R&D, profit, and operating cash flow. Process analysis considers temporal order and changing context, while pattern matching compares the evidence with the propositions in this part.

Construct validity is supported by explicit indicator definitions and source triangulation. Rival explanations are retained; revenue growth is not automatically attributed to innovation, and price declines are not automatically attributed to economies of scale. Reliability is supported by a source database and consistent coding. The study cannot observe internal managerial decisions or fully assess customer return on investment (ROI), repeat purchases, uptime and service costs. Demonstrations and company-reported use cases are not treated as independent proof of routine industrial deployment. Missing evidence is reported rather than fabricated.

Case background and technological resource development

Development trajectory

Unitree's corporate history traces its origins to quadruped-robot prototypes developed by founder Wang Xingxing and the company's establishment in 2016. Its product sequence includes Laikago, Aliengo and A1, followed by Go1 and later industrial quadruped products. The company introduced the full-size H1 humanoid robot in 2023 and the G1 in 2024 (Unitree Robotics, 2026c). This sequence shows progression from legged robot engineering toward a broader portfolio. It does not prove that every technology transfers unchanged between quadruped and humanoid platforms.

The company's official materials identify motors, reducers, controllers, light detection and ranging (LiDAR), perception and motion-control algorithms as areas of independent development and report more than 200 patent applications, including more than 180 granted patents (Unitree Robotics, 2026c). These are corporate claims and are used to identify the firm's stated resource base, not as independent evidence of technological superiority.

Resource configuration and product portfolio

The disclosed resource base can be grouped into actuation and joint hardware; sensing and perception; motion control and system integration; and higher-level intelligence. The potential strategic value lies in coordinating these layers. A product's performance depends on their integration under operating conditions, not simply on the existence of individual components. Public information does not provide controlled technical comparisons with competitors, so the study does not claim an unassailable technological moat.

The prospectus reports quadruped sales of 3,121 units in 2023, 7,136 in 2024 and 23,037 in 2025. Humanoid sales rose from five units in 2023 to 412 in 2024 and 5,215 in 2025. Humanoid shipments in 2025 were 5,511 units, exceeding sales because some units had been dispatched but had not completed customer receipt or acceptance for revenue recognition at year-end. The distinction is analytically important: Shipments are not identical to recognized sales or demonstrated productive use.

Humanoid robots generated RMB 867.83 million, or 51.78% of 2025 main-business revenue; quadruped robots generated RMB 697.63 million, or 41.62%. In 2023, quadruped robots represented 75.78% and humanoid robots 1.88% of main-business revenue. The shift consists of capability extension and product diversification. However, the evidence does not isolate which shared technologies caused the shift or whether the newer category has achieved mature industrial use. P1 is therefore supported as a plausible mechanism, not a proven causal relationship.

Dynamic capabilities in the case

The move into humanoid robots is observable evidence of strategic attention to an emerging market, but the internal sensing process is not public. Product launches, R&D commitments and production arrangements provide evidence of seizing resources. Changes in product mix and the expansion of product categories indicate commercial reorientation, although they do not independently prove internal organizational transformation. The case is consistent with sensing, seizing and transforming, but the strength of evidence is greatest for observable investments and product changes and weaker

for internal managerial processes.

Commercialization mechanisms

Product positioning and manufacturing

Unitree positions different products for consumer, education, research, professional and industrial contexts. Quadruped robots have relatively defined mobility-oriented applications, including research, education, inspection and emergency-response support. Humanoid robots have broader potential task ranges but require more demanding manipulation, autonomy, safety and integration capabilities. These differences mean that the two categories should not be treated as having identical commercialization pathways.

The prospectus describes a production arrangement in which the company retains control over product design and important assembly and quality activities while outsourcing selected processing and procuring components externally.

This is selective vertical integration combined with external supply-chain coordination, not complete vertical integration. Internal control may protect system integration, while external suppliers may provide capacity and specialist processes. The public evidence does not establish lower unit costs, higher yields or superior productivity relative to competitors. P2 is supported descriptively, while its proposed economic benefits remain unverified.

Channels and geographic composition

In 2025, offline channels accounted for 89.28% of main-business revenue: 51.10% came from offline direct sales and 38.18% from distribution. Online channels accounted for 10.72%. Overseas revenue represented 43.65% of main-business revenue in 2025, compared with 55.74% in 2024. The lower overseas share does not establish a decline in the absolute value of overseas sales. It indicates a relative change in geographic mix as domestic revenue expanded.

The channel structure combines direct and distributor relationships with online transactions. This provides multiple routes to market, but distribution may reduce the manufacturer's direct visibility into end-user operation and after-sales needs. Public disclosures do not provide sufficient evidence on distributor sell-through, repeat purchases or customer retention. Channel breadth is therefore observable; durable customer relationships are not yet demonstrated.

Applications and developer resources

Company materials position quadruped products for inspection, emergency response and other professional uses and describe developer-facing technical resources (Unitree Robotics, 2026c). Such materials establish product positioning and company-reported use cases, not independent proof of deployment scale, task success, uptime, safety or customer return on investment. A stronger assessment would require independent customer confirmation and operational data.

Developer tools and open technical resources may reduce experimentation costs. However, ecosystem theory requires evidence of independent complementors and alignment among actors whose contributions are necessary for customer value. A public software development kit (SDK) or repository does not alone establish third-party adoption or ecosystem-derived revenue. P3 is partially supported: Market-access mechanisms are visible, while repeat demand and ecosystem effects remain uncertain.

Competitive advantage and strategic constraints

Commercial scale and financial performance

Operating revenue increased from RMB 159.13 million in 2023 to RMB 392.77 million in 2024 and RMB 1.699 billion in 2025. Main-business gross margin rose from 44.22% to 56.74% and 60.13% over the same period. The growth reflects substantial commercialization, but it should be interpreted alongside product mix, pricing and accounting definitions. The prospectus reports declining average selling prices for both quadruped and humanoid robots as product portfolios and volumes changed. For quadruped robots, the average selling price declined from RMB 38,300 in 2023 to RMB 30,300 in 2025. For humanoid robots, it declined from RMB 593,400 to RMB 166,400. The company attributes revenue growth primarily to higher sales volumes, while price and product-mix changes also affected revenue.

The first nine months of 2026 show why growth quality matters. Revenue reached RMB 1.817 billion, up 55.71%. Net profit attributable to shareholders rose 270.54% but adjusted net profit declined 18.78%. R&D expenditure rose 191.48% to RMB 262.95 million, equal to 14.47% of revenue, while operating cash flow fell 54.69% to RMB 193.71 million. The report attributes the increase in reported net profit partly to the previous year’s large share-based payment expense. It contributes to the

cashflow decline mainly to higher payments for goods and services, employees, sales and R&D as the business expanded. These explanations should be reported as the company's stated explanations, not treated as independent causal proof.

Taken together, the data indicates strong revenue growth and gross margin improvement, alongside rising R&D commitments and weaker year-on-year adjusted profit and operating cash flow in the interim period. These mixed indicators do not establish financial distress, but they prevent revenue growth from serving as a sufficient proxy for sustainable advantage.

Competitive position and benchmarking

Counterpoint Research reported that global humanoid-robot sales revenue exceeded $500 million in 2025 and identified AGI + Bot (AGIBOT), Unitree, and UBTECH as the top three companies by revenue, with Unitree ranked second. The report also identified entertainment/performance and data production as major revenue-generating scenarios. This provides independent market context, but it is a commercial research estimate rather than audited industry census data. Its revenue-based ranking should not be conflated with shipment rankings or Unitree's own reported unit sales.

The evidence supports the conclusion that Unitree was a significant participant in the emerging humanoid-robot market in 2025. It does not establish a definitive market share across all robotics, nor does it prove a durable advantage over AGIBOT, UBTECH, Tesla, Figure artificial intelligence (AI) or other competitors. Comparable competitor-level data on unit costs, margins, customer retention and deployment outcomes are not sufficiently available.

Constraints and proposition assessment

Application maturity is uneven. Quadruped robots have identifiable mobility-oriented use cases, while general-purpose humanoid deployment requires reliable manipulation, autonomy, safety and integration. Company demonstrations are not substitutes for independent data on uptime, maintenance, task success and customer ROI. The hybrid production model also creates supplier-quality, delivery and capacity dependencies that cannot be quantified from available public data. International sales may face certification, service, export-control and market-access constraints. Finally, rising R&D investment must translate into measurable improvements in customer value and product performance.

P1 receives qualified support: Product diversification is consistent with technical capability reuse, but the causal contribution of particular shared technologies is not isolated. P2 is descriptively supported as a hybrid manufacturing arrangement, but cost and flexibility advantages are unproven. P3 receives partial support because multiple channels and developer resources are visible, while repeat customer demand and independent complementors are not established. P4 is supported as an evaluative proposition: Revenue, adjusted profit, cash flow and application maturity must be assessed together. The most defensible assessment is that Unitree has developed meaningful commercialization capabilities and a strong emerging market position. Whether this becomes sustained competitive advantage depends on repeatable customer value, application reliability, recurring profitability and cash generation.

Implications

Findings and theoretical implications

This study examined how Unitree Robotics converts technological innovation into commercialization and competitive positioning. Four findings emerge: First, the company's product trajectory from quadruped to humanoid robots is consistent with accumulation and possible reuse of capabilities in actuation, sensing, motion control and system integration. Second, commercialization is supported by differentiated product categories, selective internal control combined with external processing, and mixed direct, distribution and online channels. Third, Unitree achieved substantial revenue and sales growth and was identified by Counterpoint Research as a leading humanoid-robot vendor in 2025. Fourth, the sustainability of its position remains uncertain because public evidence on repeat purchases, customer ROI and routine deployment is incomplete, while 2026 interim adjusted profit and operating cash flow declined year on year.

The theoretical contribution is deliberately bounded. The case connects the resource-based view with dynamic capabilities by distinguishing resources that a firm reports possessing from processes through which it may redeploy them. It also links those processes to concrete commercialization arrangements rather than assuming that innovation directly produces performance. Finally, it

shows why commercial growth should not be equated with sustained advantage: Customer outcomes, profitability and cash conversion are necessary complementary indicators. These are analytical insights from one case, not universally validated causal laws.

Managerial implications

Robotics manufacturers should connect investment in core components and system integration to product architectures that permit reuse while recognizing that new robot categories impose distinct technical requirements. Manufacturing governance should balance internal control of critical design, integration and quality with supplier flexibility, while monitoring supplier quality, lead times and total cost. Commercialization should be assessed through task completion, uptime, maintenance, safety, repeat orders and customer return on investment, not shipment volume alone. Finally, firms should evaluate R&D intensity alongside adjusted profitability and operating cash flow.

Conclusion

Unitree demonstrates how a technology-oriented firm can build a commercial position by combining engineering resources, product diversification, manufacturing coordination and market access. Its expansion from quadruped to humanoid robotics illustrates the potential value of capability accumulation and redeployment. Yet technical visibility and rapid sales growth do not settle the question of long-term competitive advantage.

The decisive test is whether technical and commercial scale can be converted into reliable applications, repeat customer value, recurring profitability and resilient cash generation. On the public evidence available through November 2026, Unitree has established a significant emerging position in robotics commercialization, but the sustainability of that position remains an open empirical question.

Limitations and future research

The study relies on public documents and cannot directly observe internal decisions, customer experience or deployment economics. Corporate materials may emphasize selected achievements, and commercial market reports use their own definitions. A single case supports analytical explanation but not statistical generalization. Future research could compare robotics manufacturers using harmonized definitions of sales, shipments and deployments, and could use independently verified customer data on uptime, task success, maintenance, repeat orders and ROI.

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Conflicts of Interest

The author declares no conflict of interest.

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