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Innovate smarter

How AI is transforming Research and Development

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Executive Summary

As industries face increasing pressure to innovate swiftly and sustainably, integrating artificial intelligence (AI) into Research and Development (R&D) processes has become essential. AI has the potential to revolutionise R&D by addressing challenges like accelerated time to market, complex product specifications, and strict regulatory requirements.

By transforming vast data into actionable insights, AI enables organisations to streamline development, enhance resource efficiency, and bolster compliance. Key applications that are achievable with today's state of technology include variant management, requirements engineering, and regulatory alignment throughout the product lifecycle. Embracing AI requires strategic adjustments, focusing on data quality, security, availability, and empowering the workforce with new capabilities.

The PwC framework lays the groundwork for overcoming implementation barriers and fostering a culture of continuous innovation, positioning organisations for long-term success in an increasingly sustainability-focused market.

Behind the curtain Today's reality in R&D and operations

Industry challenges

As the 2025 study from PwC in collaboration with Microsoft AI in operations: Revolutionising the manufacturing industry has shown, the discrete manufacturing industry is under immense pressure to innovate. Rapidly evolving customer expectations and technological advances mean that products and processes must be improved continuously. Innovation is no longer optional; it is essential for differentiation.

Time to market has become a decisive factor in competitiveness. PwC's research from an upcoming study on the future of R&D shows that companies must accelerate their development cycles to seize opportunities while balancing speed with quality and compliance. Meanwhile, growing product complexity and portfolio diversification are challenging traditional R&D processes, necessitating more sophisticated coordination between engineering, design and supply chain functions.

Compounding these pressures is the scarcity of skilled talent. There is high demand for engineers, designers, and specialists in advanced manufacturing, which limits the capacity to scale innovation. The issue of sustainability adds another layer of complexity. Organisations are compelled to design products and processes that reduce environmental impact, optimise resources and comply with emerging regulatory and societal expectations.

Together, these factors create a challenging environment in which incremental improvements are no longer sufficient. Companies must adopt new approaches that enhance R&D effectiveness and accelerate innovation.

At the same time, AI presents a unique opportunity. Our survey report, AI in operations: Revolutionising the manufacturing industry, produced together with Microsoft, shows that artificial intelligence fosters innovation in business environments by optimising data analysis, detecting patterns and trends, and empowering informed decision-making and creative solutions. Nearly 60% of respondents expects an increase in operating profit margin through the use of AI.

The AI revolution in R&D

R&D is the cornerstone of innovation and at the heart of these challenges, making it an ideal area in which to apply artificial intelligence. AI has the power to transform the way organisations innovate, turning data into actionable insights and accelerating development and decision-making processes.

By analysing large and complex datasets, AI enables faster concept validation especially for complex systems, predictive modelling and optimised design processes, reducing reliance on costly physical prototypes. AI also helps to identify risks early on, minimise inefficiencies and align product development more accurately with market demand.

The sustainability benefits are equally compelling. AI can support the creation of resource-efficient designs and the optimisation of materials, as well as the development of circular product strategies, thereby embedding environmental responsibility into R&D from the outset.

> **Integrating AI into R&D is a strategic shift, not merely a technology upgrade. It strengthens innovation capabilities, shortens development cycles and enables manufacturers to compete effectively in a fast-moving, complex and sustainability-driven market.**

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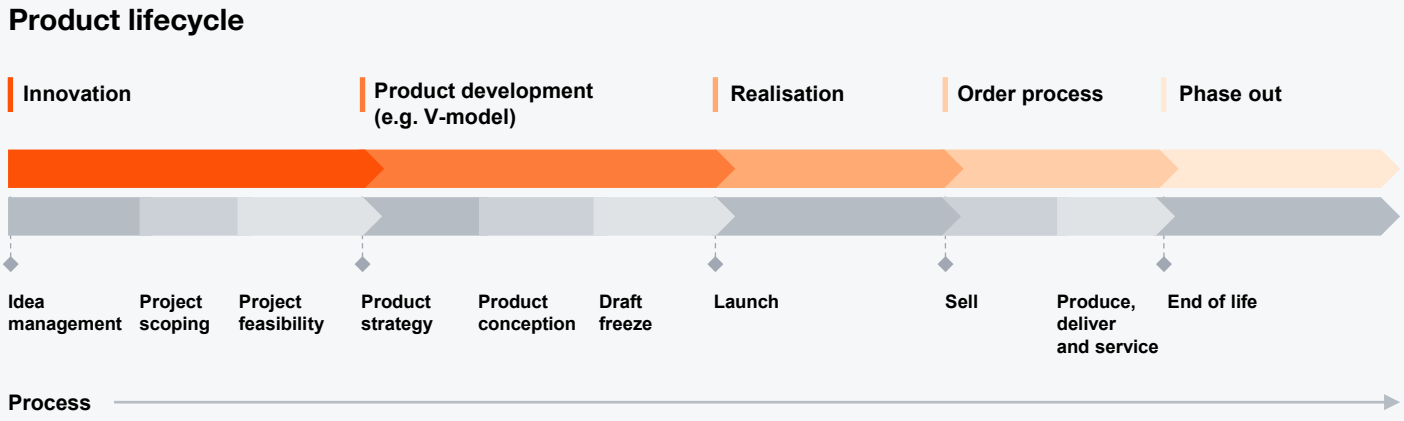
AI to support within the product lifecycle

Key valuable use cases within the product lifecycle, available today

In today's dynamic business world, the use of AI is becoming increasingly important to enhance the efficiency and competitiveness of companies. Particularly in the context of the product lifecycle, AI opens a multitude of opportunities.



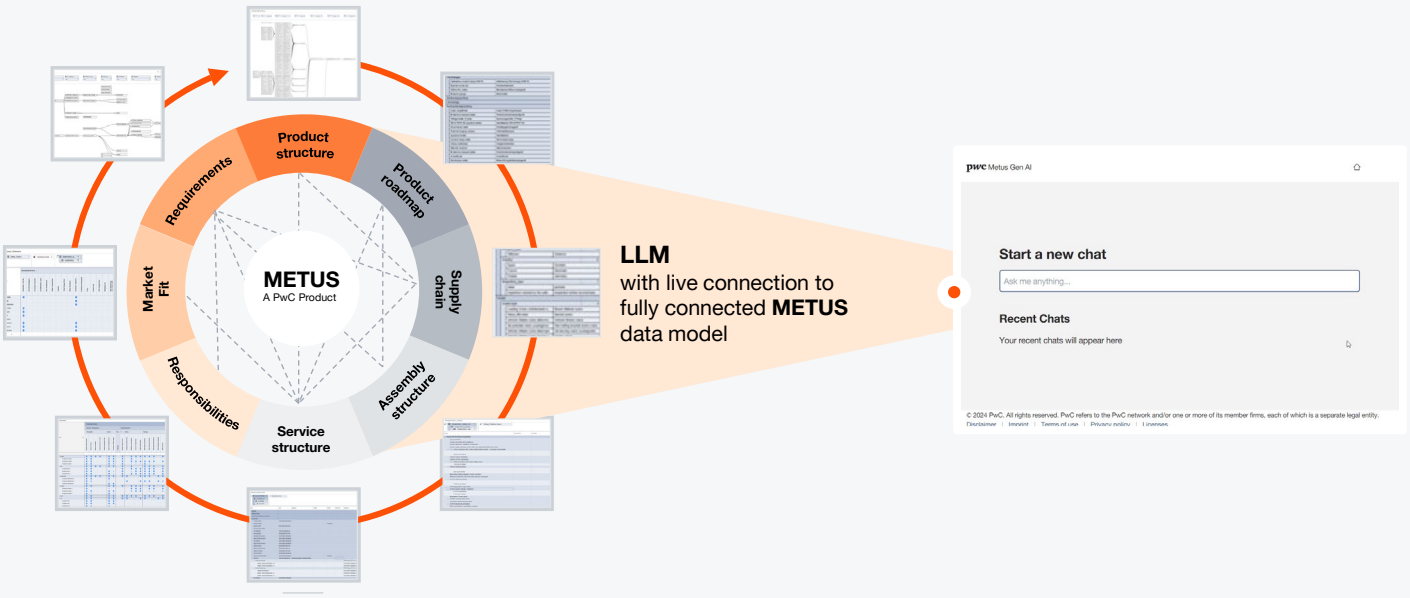
Each of the five main phases of the product lifecycle—innovation, product development, realisation, order process, and phase-out—presents challenges that are solvable with today's state of AI technology. These technologies empower companies to streamline operations, anticipate market needs, and swiftly adapt to change. It presents an opportunity to accelerate time to market timelines, improve products by cost and innovation, ease workload for resources, improve R&D power by facilitating collaboration, alignment and coordination, to name only a few of AI's value drivers. The following sections present mature use cases for AI within the product lifecycle.

AI to optimise variant and complexity management

In product development, mastering variant management is often challenging due to its inherent complexity, necessitating innovative solutions in R&D. The key lies in effectively managing external and internal complexities—balancing portfolio, module, and component variants with customer requirements. Rather than eliminating complexity, the goal is to harmonise market needs with company offerings. Utilising real data, like sales figures, is crucial to quantifying and valuing this complexity.

Effective variant management distinguishes 'high runners' from 'low runners' and links these to technical implications, such as the number and severity of component variants required. Misjudging the cost of complexity can lead to financial inefficiencies and over-engineering. Many complexity management solutions are often impractical and further complicate matters.

Current AI solutions tailored for R&D, like PwC's METUS*, address these challenges by optimising product configurations using advanced algorithms. They help reduce unnecessary complexity, minimise component counts, and maintain a wide range of configuration options. METUS leverages AI to quantify the impact of external variety on a portfolio, evaluate technology options, and propose balanced solutions. Drawing on insights from our client engagements and experience, this leads to resource efficiencies, achieving up to 50% variant savings, 25% component reductions, and up to 33% cost savings—enhancing agility and market responsiveness.

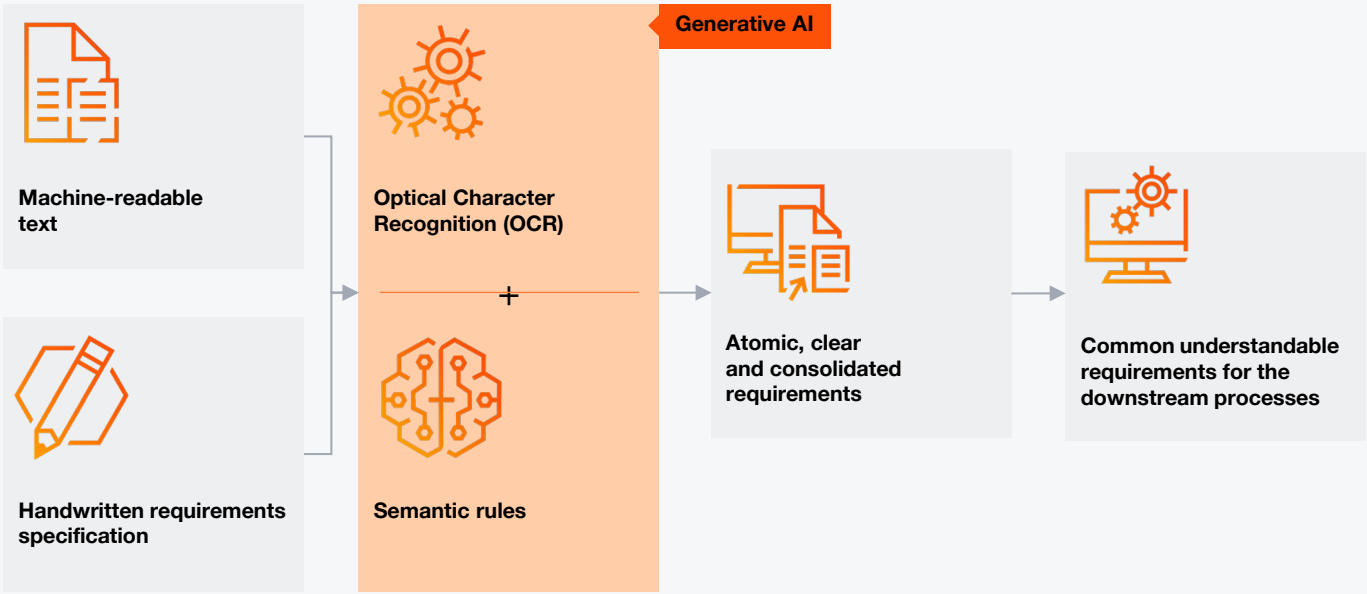


AI to drive requirements engineering

Requirements engineering provides the foundation for product development. Weak requirements engineering can slow progress and increase risk. It can lead to fragmented communication, incomplete or inconsistent documentation, and scope misalignment—sometimes even commercial failures, when products miss the mark with customers or the market.

*PwC's METUS is an advanced methodology and software suite designed to optimise product development and portfolio management. Leveraging AI, METUS enables organisations to systematically manage their products and services. The platform supports end-to-end and cross-departmental digital modeling and integrates seamlessly with PLM/ERP systems. For more information, visit: https://pwc.to/3JEzMTH

Operationally, poor requirements management drives delays, cost overruns, and resource inefficiencies. Misalignment among teams and a lack of clarity on project objectives further exacerbate these challenges, compromising the product's quality and alignment with client needs.

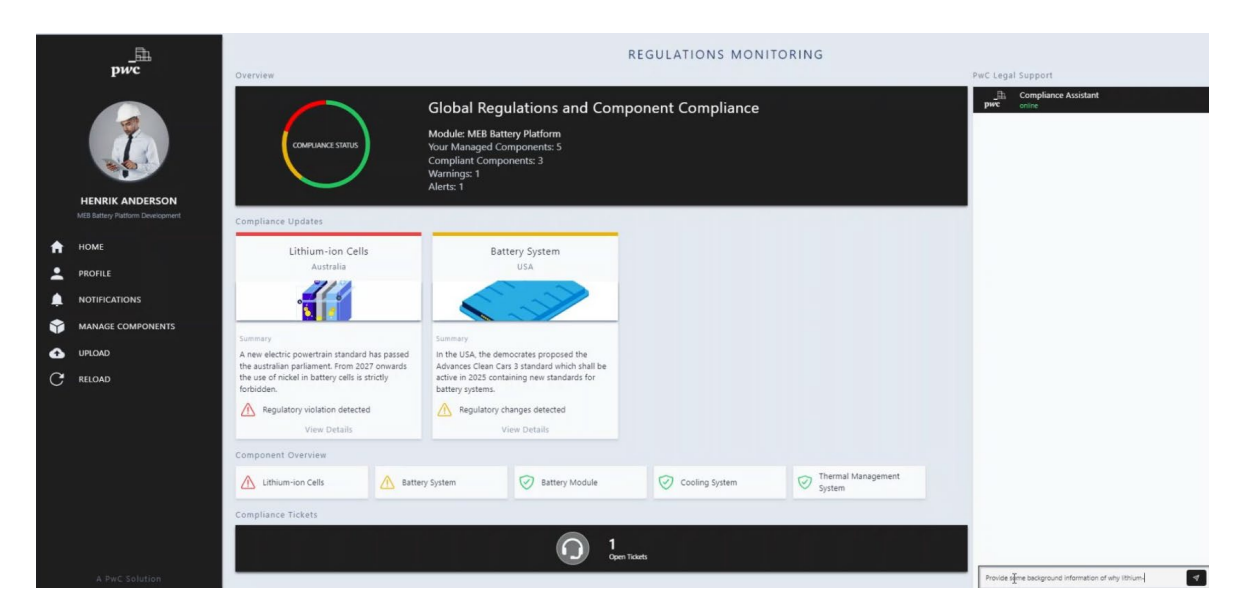


Generative AI addresses these issues by enabling instant extraction and consolidation of requirements using semantics and optical character recognition (OCR) to translate handwritten information into machine-readable text. Our work with clients demonstrates that AI-driven systems can reduce requirements derivation time by ~60%, documentation effort by up to 30–40% and decrease rework by ~25% through improved requirement consistency, resulting in faster development cycles and better alignment between design outcomes and customer expectations.

AI to facilitate compliance as part of R&D

In today's world, the functions of R&D and compliance are becoming increasingly connected—even integrated. This is due to continuously increasing regulatory requirements that cause compliance to become an integral part of phases where products are created and modified. Current challenges in product compliance include high manual effort to interpret complex regulations, evaluating and mitigation of risk of non-compliance from inconsistent implementation, and time-intensive audit preparation. AI technology can support in these tasks already.

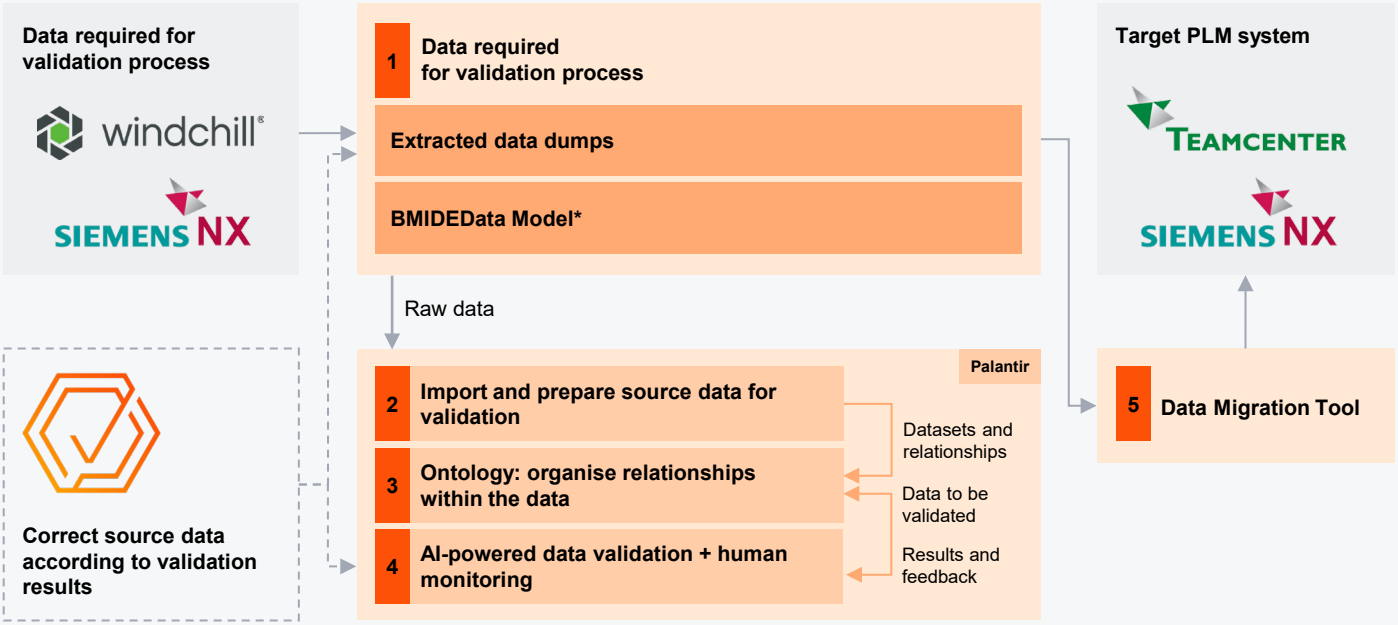
Our experience shows that an AI-powered compliance assistant is an effective solution. It identifies global regulatory changes, translates them to your portfolio, and helps evaluate necessary modifications across systems and sub-systems. We have seen such technology effectively span from automatic scanning to evaluation of current compliance, through to connecting to R&D departments to execute needed changes. It thereby streamlines the process and reduces human error. The benefits of this AI-integrated system are substantial, it achieves approximately 50% time reduction, up to 60-70% reduction in manual effort, and ~40% error reduction. These improvements not only reduce audit costs but also enhance accuracy and efficiency, fostering a more reliable and compliant R&D environment.



AI to boost data migration

Data migration programmes often take several years to execute. In R&D, product lifecycle management (PLM) transformations are common—and they typically involve migrating large volumes of data. Frequently, we see a significant volume of resources being dedicated for the sole purpose of such data migrations. Traditionally, it is often a very manual process for data to be validated, exported and imported from different data domains within the product development process (e.g., CAD, BOMs). Companies often deal with a large volume of data to be handled and seek specialist expertise and consistent involvement, making the entire endeavour time-consuming and expensive.

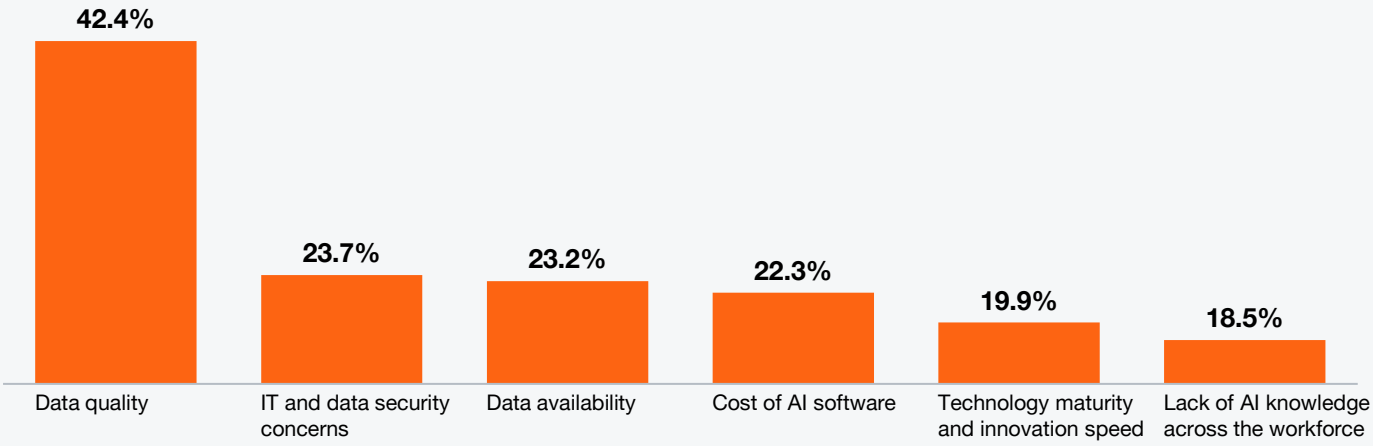
AI-based solutions with today's state of technology can automate data migration and validation processes already. They can support in extracting data, integrating documents, and cross-checking validation results. Key benefits seen in our projects work include time savings of up to 60% through accelerated task execution, potential cost reductions of approximately 50% in project delivery, and thorough data protection that requires only about 25% involvement from specialist staff. The implementation of AI-driven efficiencies enhances both large-scale data migration and adaptive validation.



Building an AI-enabled R&D organisation

The implementation of AI presents immense potential and transformative power across various industries and business processes, as analysed in detail by PwC and Microsoft's AI in Operations study. However, despite the technological advancements and the promised benefits of AI, organisations face a multitude of challenges that hinder successful deployment and utilisation. The following chart shows a number of noteworthy factors that are widely prevalent and deeply entrenched in operational and strategic processes. We discuss each of these in more detail in the next section.

Biggest challenges to implement AI



Source: PwC and Microsoft, AI in operations: Revolutionising the manufacturing industry

Why clean, consistent data is critical for AI success

Data forms the bedrock of any AI implementation, and its quality fundamentally dictates the efficiency and performance of algorithms. In R&D, data quality issues often arise from inconsistencies in test-bench measurements and undocumented design iterations. Legacy PLM and simulation systems may store results in incompatible formats or lack standardised metadata, complicating cross-project analyses. Consequently, AI models trained on such fragmented and error-prone datasets can yield unreliable predictions and limit the discovery of meaningful design insights.

Safeguarding systems in an increasingly connected world

Protecting sensitive information and establishing data integrity are paramount when implementing AI systems. The increasing integration and interconnectivity of systems elevate the risk of cyber-attacks and data breaches. Organisations must implement robust security measures to combat these threats. This challenge arises from a continuously evolving threat landscape and a frequently insufficient preparedness to meet new security requirements.

Breaking down silos to unlock usable data

Another significant challenge pertains to the availability of the required volume and diversity of data necessary for training AI models. Often, the essential data either does not exist in the desired format or is difficult to access. This challenge is deeply rooted in historically developed information silos and proprietary databases that hinder smooth data flow. Companies must strategise to collect and provide data more efficiently.

Balancing innovation with investment

Investing in AI technologies can involve substantial financial and human resources. The costs associated with developing, deploying, and maintaining AI systems pose a substantial economic hurdle for many enterprises. This challenge is frequently linked to the necessity of acquiring specialised software solutions and engaging professionals for system oversight and development.

Keeping pace with rapid AI evolution

The rapidly evolving landscape of AI technology brings forth both opportunities and challenges. Organisations find it difficult to keep pace with the innovation speed and continually update their systems. This challenge originates from the nature of the technology itself, as new breakthroughs and improvements occur in rapid succession, rendering existing systems and processes quickly obsolete.

Building capability to drive adoption

Another prominent barrier is the general lack of knowledge and skills related to AI within the workforce. To integrate AI successfully, knowledge of the technology must be widely disseminated, necessitating targeted training and education. The origin of this challenge lies in the relatively novel nature of AI technologies and the shortage of established educational frameworks.

These challenges highlight the complexity of AI implementation and elucidate how deeply their causes and prevalence are rooted within corporate culture and existing technologies. A strategic approach encompassing both technological and organisational solutions is imperative to overcome these barriers successfully.

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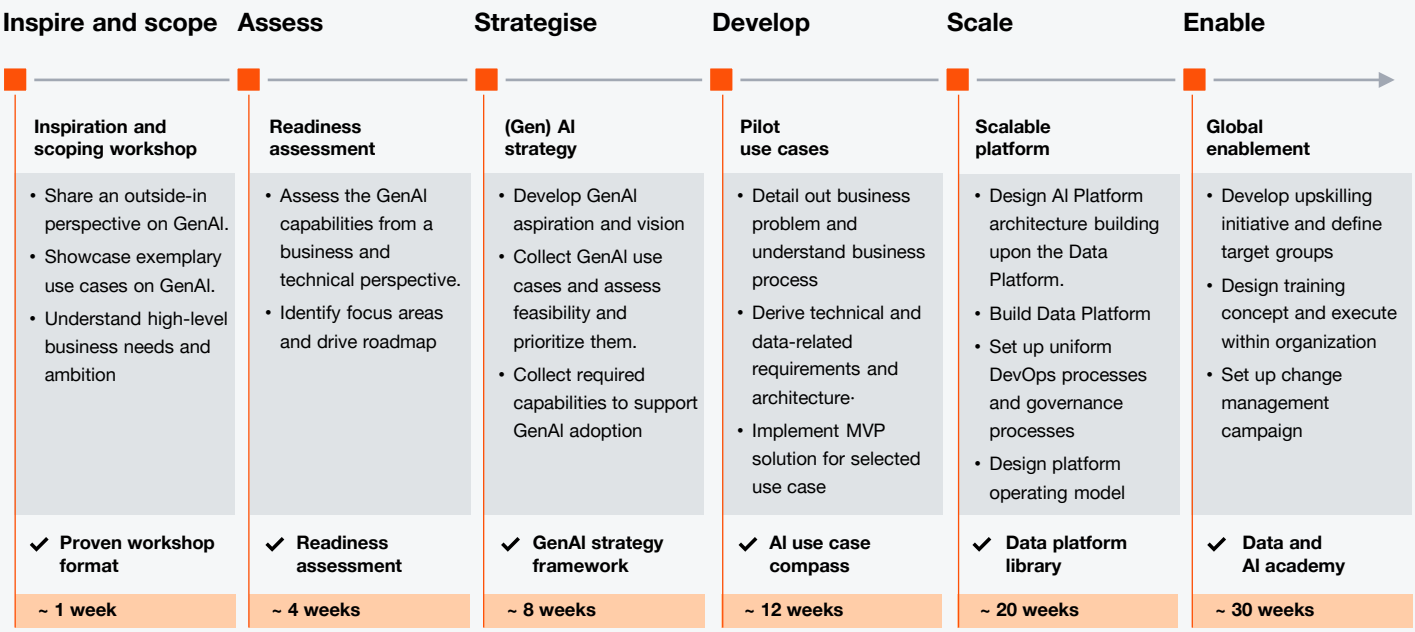
Successful AI implementations are business-led, not tech-led

A business-led approach is necessary to align AI initiatives with organisational strategy effectively, integrating AI into a comprehensive framework that encompasses key dimensions—strategy, products, processes, IT-technology, and organisation. This synergistic approach begins with inspiring and defining the vision for AI adoption, ensuring alignment with the organisation's strategic objectives and high-level business ambitions.

Initially, by focusing on aligning AI capabilities with strategic goals, organisations can identify impactful use cases and assess readiness from both business and technical perspectives. This alignment is crucial for ensuring that AI solutions enhance existing processes, driving innovation and competitive advantage.

PwC supports clients from initial scoping to end-to-end implementation and brings in accelerators in every stage



Strategising becomes a focal point, where detailed plans are crafted to support AI adoption. This involves prioritising high-impact use cases, fostering end-to-end continuity in processes, and creating scalable solutions that integrate seamlessly into existing IT frameworks. The emphasis here is on enhancing operational efficiency and enabling faster time-to-market through efficient engineering practices and robust data infrastructures.

Development of pilot use cases follows, where technical architectures are specified and Minimum Viable Product (MVP) solutions are implemented to yield immediate value. This phase underscores the practical application of AI, demonstrating tangible outcomes that inform broader integration strategies, supported by seamless toolchains that enhance capabilities. To effectively develop and integrate AI use cases, partnering with a technology provider like Microsoft offers substantial advantages and delivers improved outcomes.

Leveraging preconfigured services and established best practices reduces development and implementation complexity, thereby accelerating time to value. Furthermore, the collaboration enables the application of state-of-the-art IT security controls to mitigate security and compliance risks and ensure the secure, compliant deployment of AI across the organisation.

Finally, organisational enablement is a critical component of the AI approach, reinforcing the business-led methodology. By focusing on advancing workforce capabilities and implementing effective governance models, organisations cultivate a culture of continuous R&D and innovation. Comprehensive training and strategic change management ensure sustainable integration, embedding AI within the organisational ethos and driving long-term success.

By integrating these components, organisations can leverage AI effectively, enabling implementations that are strategically aligned and optimise the potential for transformative impact across the enterprise.

4

Conclusion

In conclusion, the integration of AI into R&D represents a transformative opportunity for industries facing the dual pressures of rapid innovation and sustainability demands. As highlighted throughout the whitepaper, AI's potential to revolutionise R&D processes is evident in its ability to accelerate time to market, address product complexity, and ensure regulatory compliance. By enabling the transformation of extensive data into actionable insights, AI offers organisations the tools to streamline development, enhance resource efficiency, and strengthen compliance protocols. The emphasis on variant management, requirements engineering, and regulatory alignment underscores AI's critical role in overcoming traditional R&D challenges and fostering a culture of continuous innovation.

However, successful AI adoption requires strategic shifts that prioritise data quality, security, and availability, as well as workforce empowerment through skill development and education. The outlined business-led approach, which aligns AI initiatives with organisational strategy across five key dimensions—strategy, products, processes, IT-technology, and organisation—provides a comprehensive framework for AI integration. By identifying impactful use cases and implementing pilot solutions, organisations can effectively harness AI to enhance operational efficiency and market competitiveness. Ultimately, cultivating an AI-enabled R&D environment not only supports immediate business goals but also positions organisations for long-term success in a sustainability-focused marketplace, ensuring they remain at the forefront of innovation and industry leadership.

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