# **The Tangible Impact of Internally Leveraged AI Knowledge Systems in Manufacturing and Operational SMBs**

Executive Summary:

The integration of Artificial Intelligence (AI) into business operations is no longer a futuristic concept but a present-day reality, offering substantial benefits for Small and Medium-sized Businesses (SMBs), particularly in manufacturing and operational sectors. This report synthesizes quantitative data, case study results, and benchmarks from 2020 onwards to illuminate the impact of AI-powered knowledge bases and similar in-house AI tools. While purely internally developed AI solutions by SMBs are an emerging area for detailed public documentation, analysis of analogous large enterprise initiatives, vendor-facilitated SMB successes, and the rise of accessible AI platforms provides compelling evidence of significant operational improvements.

Key findings indicate that AI implementation can lead to dramatic reductions in equipment downtime (up to 50%) and maintenance costs (up to 40%), substantial increases in First Pass Yield (FPY) (e.g., 25-30% defect reduction), and significant decreases in information search time, thereby boosting employee productivity (with 90% of AI-using knowledge workers reporting higher productivity). Furthermore, AI-driven onboarding and training systems have demonstrated capabilities to reduce onboarding time by as much as 40% and cut time-to-productivity by approximately 30%.

The Return on Investment (ROI) for these initiatives varies, with some projects achieving payback in under a year, particularly when focused on high-impact areas. Strategic advantages extend beyond direct financial returns, encompassing enhanced decision-making, knowledge retention, operational agility, and a unique competitive edge derived from leveraging proprietary internal knowledge. For SMBs, the path to "in-house" AI often involves customizing existing AI platforms or utilizing citizen developer tools, making such initiatives increasingly feasible. Critical success factors include a robust data strategy, a phased implementation approach, clear objective setting, and effective change management. As AI technology continues to evolve towards greater accessibility and power, SMBs are increasingly well-positioned to harness internal AI for a competitive and efficient future.

**I. The Imperative for Intelligent Operations: AI in Manufacturing and Operational SMBs**

A. The Evolving Landscape: AI Adoption Trends and SMB Relevance

The manufacturing sector is undergoing a significant transformation driven by the adoption of Artificial Intelligence. Current trends indicate a widespread embrace of AI technologies, with 90% of manufacturers globally prioritizing AI integration and 77% having already initiated implementation.1 This momentum is reflected in market projections, which estimate the manufacturing AI market will expand from USD 3.2 billion in 2023 to USD 20.8 billion by 2028, a compound annual growth rate indicative of rapid and sustained investment.1

This AI adoption is not confined to large corporations; Small and Medium-sized Businesses (SMBs) are also actively participating. Data reveals that 75% of SMBs are, at a minimum, experimenting with AI, and this figure rises to 83% among growing SMBs. A compelling 91% of SMBs already utilizing AI report that it contributes to revenue boosts.2 These figures underscore that AI is increasingly perceived not as a luxury but as a viable and valuable tool for businesses of all sizes. Further supporting this, a study by the St Andrews Business School found that SMBs implementing AI tools can achieve productivity gains ranging from 27% to 133%. Service-oriented businesses, a category that can encompass the operational service aspects of many manufacturing SMBs, were noted as significant beneficiaries.3

The active engagement of SMBs with AI, driven by tangible outcomes like enhanced revenue and productivity, challenges any notion that AI is too complex or costly for smaller enterprises. Instead, the data points towards a strong attraction based on demonstrable benefits. This suggests that SMBs are successfully identifying and implementing practical AI use cases that deliver value. The substantial projected growth in the manufacturing AI market also implies an increasing maturation of AI solutions and a broadening array of tools and platforms. This market expansion is likely to foster greater diversification in offerings and potentially more competitive pricing, making AI technologies, including those suitable for in-house customization or development, more accessible to SMBs.

B. Defining "In-House" AI: From Custom-Built Systems to Leveraged Platforms

The concept of "internally developed" or "in-house" AI encompasses a spectrum of approaches. At one end lies the ground-up creation of algorithms and systems, often seen in large enterprises with substantial research and development capabilities. An example is BMW's use of "in-house machine-learning models" for predictive maintenance at its Regensburg plant.4 At the other end, and more commonly for SMBs, "in-house" involves leveraging existing third-party AI platforms and customizing them with proprietary data and specific workflows. For instance, Georgia-Pacific utilized the SAS Viya analytics platform, running on Amazon Web Services (AWS), to develop its AI-driven equipment monitoring systems.5 Understanding this spectrum is crucial for SMBs considering their AI strategy.

The emergence of "citizen development" platforms, which are increasingly AI-powered, further broadens the definition of in-house AI. These platforms empower business users with limited or no traditional coding skills to build and deploy applications.6 For SMBs, such tools can facilitate the creation of tailored AI solutions for tasks like workflow automation, data analysis, and the development of interfaces for internal knowledge bases, effectively bringing AI development capabilities within reach without requiring extensive specialist teams.

For many SMBs, therefore, "in-house AI" is more likely to manifest as the strategic application and customization of existing AI platforms and tools rather than the construction of foundational AI models from the ground up. This approach significantly lowers the barrier to entry, making sophisticated AI capabilities accessible. The critical "in-house" component in such scenarios is often the proprietary operational data and the unique business context that the AI system is trained on or interacts with, regardless of the origin of the core AI engine itself. The effectiveness of AI, especially in knowledge management, troubleshooting, or operational optimization, is deeply tied to its understanding of a company's specific processes, equipment characteristics, historical performance, and accumulated internal knowledge.8 For example, Retrieval Augmented Generation (RAG) systems trained on a company's own data can provide highly relevant and contextualized information.10 Even when using a vendor-supplied AI search tool, its true value is unlocked by its ability to index, comprehend, and retrieve information from the SMB's internal documents, databases, and operational logs.11

C. The Knowledge Gap: Challenges in Quantifying Impact for Truly Internally Developed Tools in SMBs

While the potential of AI for SMBs is evident, a notable challenge exists in finding publicly available, detailed quantitative case studies that specifically focus on purely internally developed AI tools within this segment. The majority of well-documented successes featuring granular metrics tend to originate from vendor-publicized implementations (e.g., ThroughPut's AI platform 9, Odin AI's solution for Skyhigh Security 13, or Augmentir's connected worker platform 14) or from large enterprises possessing significant resources for both development and impact analysis (e.g., BMW 4, ASML partnering with Google Cloud and ML6 5).

Surveys, such as the CohnReznick Manufacturing Checkup, confirm that SMBs are indeed investing in AI and observing positive impacts. However, these surveys often do not provide the specific, KPI-focused quantitative data for internally built tools that decision-makers seek.15 The same study also noted that 57% of manufacturers report "complete outside support" for AI policy and governance, hinting at a degree of reliance on external expertise, which can blur the lines of what is considered purely "in-house."

To address this knowledge gap, this report will strategically incorporate analogous data from larger companies or vendor-driven SMB successes. The context of these examples will be clearly delineated, and the emphasis will be on how the underlying principles and potential benefits are transferable to SMBs pursuing their own in-house AI solutions. For example, if a large corporation achieves a certain percentage reduction in downtime with an internally developed predictive maintenance AI, an SMB with a well-defined scope and quality data might reasonably expect a proportional, albeit scaled, benefit.

The "black box" nature attributed to some AI systems, where the internal workings are not entirely transparent 16, alongside the inherent difficulty in isolating AI's precise impact from other concurrent business improvements or changes, can also make exact quantification challenging. This is particularly true for SMBs that may not have dedicated data analytics teams to conduct rigorous impact studies. Such complexities might explain why many SMBs report general benefits from AI 2 but may lack the detailed KPI breakdowns for specific, internally developed tools.

**II. Measurable Gains: AI's Impact on Core Manufacturing and Operational Metrics**

The implementation of AI-powered tools, whether fully internally developed or significantly customized in-house, is demonstrating tangible improvements across key performance indicators in manufacturing and operational settings. The following table summarizes some of the notable quantitative impacts reported since 2020.

**Table 1: Summary of Quantified Impacts from AI Implementation in Manufacturing and Operations (2020 onwards)**

| **Metric** | **Specific Impact** | **Company/Study Context** | **Tool Context** | **Sector** | **Company Size (if available)** | **Source(s)** |
| --- | --- | --- | --- | --- | --- | --- |
| Downtime Decrease | Up to 50% reduction | General Manufacturing (Industry Stat) | AI-driven automation, Predictive Maintenance | Manufacturing | N/A | 4 |
| Downtime Decrease | 30% reduction in unplanned downtime | Georgia-Pacific (Large Enterprise) | Leveraged AI Platform (SAS Viya on AWS) | Paper Products | Large | 5 |
| Downtime Decrease | Saved >500 minutes of disruption/year per plant | BMW (Large Enterprise) | In-house Machine Learning Models | Automotive | Large | 4 |
| Productivity Savings | Recovered $0.5M in weekly losses | Global Food Manufacturer (Vendor Solution) | AI Platform (ThroughPut) for predictive maint. | Food & Beverage | Global | 9 |
| Maintenance Cost Reduction | Up to 40% reduction | General Manufacturing (Industry Stat) | AI-powered Predictive Maintenance | Manufacturing | N/A | 17 |
| MTTR Reduction (Proxy) | Ticket resolution from 1.5 days to "few hours" | Skyhigh Security (Analogous - Tech) (Vendor Solution) | AI Agent for technical document search (Odin AI) | Cybersecurity | N/A | 13 |
| FPY Increase (Defects) | 30% reduction in customer rejections/returns | Epiroc (Large Enterprise) | Leveraged AI Platform (Azure ML) | Construction Tools | Large | 5 |
| FPY Increase (Defects) | 25% reduction in defects | Siemens Gamesa (Large Enterprise) | Vendor-developed ML system (IBM) | Renewable Energy | Large | 5 |
| Information Search Time | 90% of AI users report higher productivity (partly due to reduced search time) | Slack State of Work Report (Knowledge Workers) | General AI tools | Various | N/A | 10 |
| Onboarding Time Reduction | 40% reduction | Leading Battery Manufacturer (Vendor Solution) | AI-powered Connected Worker Platform (Augmentir) | Manufacturing | Leading | 14 |
| Time-to-Productivity Red. | ~30% reduction (also training cost reduction) | SaaS Provider for Manufacturers (Vendor Co-developed) | GenAI SOP Creation (Quantiphi/AWS/Claude V3) | SaaS for Mfg. | N/A | 18 |
| SOP Creation Time Red. | 70% reduction | SaaS Provider for Manufacturers (Vendor Co-developed) | GenAI SOP Creation (Quantiphi/AWS/Claude V3) | SaaS for Mfg. | N/A | 18 |
| Output Increase | 5% improvement | Global Food Manufacturer (Vendor Solution) | AI Platform (ThroughPut) for machine utilization | Food & Beverage | Global | 9 |

A. Slashing Downtime and Enhancing Asset Reliability (MTTR & Downtime Decrease)

A primary application of AI in manufacturing and operations is the significant reduction of equipment downtime and the associated improvement in asset reliability. Industry analyses suggest that AI can curtail manufacturing downtime by as much as 50% and concurrently reduce maintenance costs by up to 40%.17 IBM has also projected that the synergistic use of AI and the Internet of Things (IoT) can lead to a 50% decrease in downtime, a 70% reduction in breakdowns, and a 25% cut in overall maintenance expenditures.4

These substantial gains are often achieved by shifting maintenance paradigms from reactive or scheduled preventive measures to a *predictive* stance. AI algorithms analyze vast streams of sensor data and historical operational logs to identify subtle patterns and anomalies that precede equipment failures.9 For instance, BMW's Regensburg plant successfully implemented "in-house machine-learning models" trained on its historical equipment data. These models create heat maps visualizing fault patterns, enabling maintenance teams to proactively address potential issues, thereby saving "more than 500 minutes" of production disruption annually per plant.4 This case exemplifies how internal AI development, leveraging proprietary data, can yield tangible time-based savings in large enterprises, a principle applicable to focused SMB initiatives. Similarly, Georgia-Pacific, by utilizing SAS Viya on AWS to monitor its equipment, achieved a 30% reduction in unplanned downtime in facilities where these AI tools were deployed, demonstrating the efficacy of leveraging advanced analytics platforms with internal data.5

While the above are large enterprises, the benefits extend to operations that may be more comparable in scale or focus to SMBs when vendor solutions are considered. A global food manufacturer, employing ThroughPut's AI platform, managed to recover USD 0.5 million in weekly productivity losses and significantly reduce unplanned downtime. This was achieved by the AI system predicting potential equipment failures through the analysis of both historical and real-time machine performance data.9 The core requirement for such systems, whether vendor-supplied or internally developed by an SMB, is a robust data infrastructure capable of capturing reliable data streams from operational equipment.

Beyond preventing downtime, AI also contributes to reducing Mean Time To Repair (MTTR) when failures do occur. AI systems can expedite the diagnostic and repair process by providing "detailed troubleshooting steps" directly to technicians.21 Generative AI, for example, can rapidly decipher incident messages and accurately route them, thereby improving overall incident response times.22 An analogous situation, though outside manufacturing, is seen in the Skyhigh Security case study. By implementing an AI agent (from Odin AI) for technical document search, the company saw its average ticket resolution time—a proxy for MTTR in service operations—plummet from 1.5 days to just "a few hours".13 This highlights that faster access to the correct information (such as troubleshooting guides, historical repair logs, or standard operating procedures for repair) logically translates to a reduction in MTTR. If technicians can quickly find the solution or diagnostic pathway, the equipment is restored to operational status more rapidly.

B. Elevating Quality: FPY Improvement and Defect Minimization

First Pass Yield (FPY), a critical metric for manufacturing quality and efficiency, is another area where AI demonstrates significant impact. AI technologies, particularly computer vision and machine learning algorithms, are adept at enhancing quality control by detecting defects in real-time and assisting in the identification of their root causes.8 The potential for AI in this domain is substantial; for instance, academic research by Duc and Bilik (2022) highlighted a scenario where computer vision and AI applied to detect surface scratches in a machining center reduced defective parts from 100% to zero.24

Several large enterprises have reported considerable FPY improvements through AI. Epiroc, a Swedish manufacturer of construction tools, utilized Microsoft Azure Machine Learning to predict steel properties. This initiative resulted in a 30% reduction in customer rejections and product returns, directly reflecting an improvement in the final quality of products reaching the customer.5 Similarly, Siemens Gamesa implemented a machine learning system, developed in partnership with IBM, which incorporated computer vision for the inspection of fiberglass layers in wind turbine blades. This AI-driven inspection process led to a 25% reduction in defects.5

The enhancement of FPY through AI is typically linked to improved process control and the automation of defect detection. For an SMB aiming to develop an in-house AI system for quality improvement, this necessitates the integration of AI tools with existing production line sensors and data acquisition systems. Platforms like QualityLine, for example, achieve this by integrating data from various sources such as Surface Mount Technology (SMT) machines and Automated Optical Inspection (AOI) systems to provide actionable insights into the manufacturing process.23 Furthermore, monitoring critical production environment factors (e.g., how ambient temperature fluctuations might affect FPY) and machine performance metrics (like Mean Time To Failure or MTTR), and then correlating these with FPY outcomes, is a key strategy that AI can facilitate.25

While a traditional "knowledge base" might not be the direct tool for real-time defect detection, an AI-powered system that documents best practices, optimal machine settings derived from AI-driven analysis, and proven solutions to past quality issues can indirectly support FPY. By ensuring that operators consistently follow optimized procedures and have access to validated setup instructions, such an AI knowledge system helps maintain process stability and contributes to higher, more consistent FPY. This creates a valuable link between the analytical power of AI in identifying optimal conditions and the practical execution of tasks on the shop floor.

C. Streamlining Information Access and Troubleshooting (Information Search Time Reduction & Support Agent Efficiency)

A significant drain on productivity in many operational environments, including manufacturing, is the time employees spend searching for necessary information. AI-powered enterprise search and knowledge management systems are designed to combat this inefficiency by providing precise, context-aware results almost instantaneously.10 The impact can be substantial; Slack's "State of Work 2023" report found that 90% of knowledge workers who use AI tools report higher levels of productivity, largely attributing this gain to the elimination of time-consuming information searches.10

A compelling case, analogous to the needs of manufacturing technicians, is that of Skyhigh Security. This cybersecurity company implemented an AI agent developed by Odin AI for technical document search. Before this, their technicians spent approximately 3 hours daily searching for documents. Post-implementation, this search time was drastically reduced, contributing to a fall in average ticket resolution time from 1.5 days to mere hours.13 This scenario is highly relevant for manufacturing settings where engineers and technicians frequently need rapid access to Standard Operating Procedures (SOPs), equipment manuals, schematics, and historical troubleshooting data. The ability of AI to quickly surface the correct document or procedure can translate directly into reduced diagnostic time and faster problem resolution on the factory floor. Siemens, for instance, notes that AI co-pilots can help answer system-related questions and transform lengthy, complex PDF documents into structured, actionable insights, thereby making information more accessible and usable.27

The effectiveness of these AI systems hinges on key capabilities. Natural Language Processing (NLP) is crucial, as it allows users to pose questions in everyday language rather than needing to know specific keywords or technical jargon.10 Advanced AI can also understand the context of a query, search across diverse and heterogeneous datasets (including unstructured sources like internal emails or maintenance ticket comments), and provide contextual recommendations for further action or related information.26 Furthermore, features like AI-driven automated content tagging and categorization significantly improve the discoverability of knowledge assets within the system.26

For support agent efficiency, whether internal support for operational staff or external customer support, AI offers similar advantages. It can analyze an ongoing workflow, such as resolving an equipment issue or a customer ticket, and provide contextual recommendations for the next best actions. This allows agents to directly utilize curated solutions without extensive manual searching or data collation.26 For customer-facing teams in manufacturing SMBs (e.g., after-sales service), instant access to product details, customer interaction histories, and relevant solution documentation enables faster and more accurate responses, enhancing customer satisfaction.10

The most immediate and significant impact of an in-house AI knowledge base for manufacturing SMBs is likely to be the substantial reduction in information search time for operational staff. This directly boosts their efficiency, minimizes delays in problem-solving, and allows for quicker execution of tasks. However, for such an "in-house" AI search or knowledge base to deliver these benefits, considerable effort must be dedicated to data preparation. This includes digitizing physical documents, ensuring the quality and accuracy of existing digital data, and potentially undertaking initial manual tagging or structuring if the AI's automated capabilities are not sufficiently advanced at the outset.12 An SMB cannot merely deploy an AI tool over a disorganized collection of outdated files and expect optimal performance; the development of an in-house AI tool must be coupled with disciplined knowledge management practices.

D. Accelerating Workforce Proficiency: Onboarding and Training (Onboarding Time Reduction)

Traditional onboarding processes in manufacturing often present significant challenges, including steep learning curves for new hires and the delivery of generic training modules that may not adequately address job-specific hazards or complexities.29 AI offers transformative solutions by personalizing training content, enhancing knowledge retention through adaptive learning, and automating various aspects of training delivery and support.21

Direct quantitative impacts have been observed in manufacturing settings. For example, a leading battery manufacturer that implemented Augmentir's AI-powered connected worker platform reported a 40% reduction in onboarding time.14 This is a clear, measurable benefit directly attributable to AI in a manufacturing context. Another relevant case involves a Software-as-a-Service (SaaS) provider catering to manufacturers. By co-developing a Generative AI solution with Quantiphi (utilizing Amazon Bedrock and Anthropic's Claude V3 model) for creating and managing Standard Operating Procedures (SOPs), they achieved an approximate 30% reduction in training costs and time-to-productivity for users of their platform, alongside a 70% reduction in SOP creation time.18 This is pertinent as effective SOPs are fundamental to efficient training and consistent operations in manufacturing.

Broader studies, while not exclusively focused on manufacturing, also indicate strong positive trends. A 2022 Talent Board study found that the use of AI in onboarding processes reduced the time spent on manual administrative tasks by 50%. Research from Deloitte indicated that organizations utilizing AI-powered onboarding solutions saw a 64% increase in new hire productivity within their first 90 days.30 These general findings reinforce the potential for significant efficiency gains.

An AI-powered knowledge base plays a pivotal role in this accelerated proficiency. It can function as a dynamic, interactive learning resource, providing instant answers to new hires' questions, offering easy access to SOPs, troubleshooting guides, and safety protocols, and even delivering bite-sized micro-learning modules on demand.26 Furthermore, AI systems can assist in generating training materials by repurposing content from existing documents, manuals, or even video recordings of expert procedures.14

The capacity of AI-powered knowledge systems to significantly reduce onboarding time stems not just from structured content delivery but, crucially, from providing continuous, on-demand support and answers. This empowers new hires to become self-sufficient more quickly, reducing their reliance on senior staff for routine questions and allowing them to independently find the information needed to perform their tasks correctly and safely.12 The 40% reduction in onboarding time observed at the battery manufacturer serves as a strong testament to this capability.14

An often-underestimated benefit is AI's ability to streamline the creation and maintenance of training materials, particularly SOPs. Outdated or poorly written documentation is a major impediment to effective onboarding and consistent operational performance. If AI tools can help generate clear, concise, and current SOPs from diverse inputs like videos, expert notes, or existing (but perhaps unstructured) documents, the quality and speed of onboarding are inherently improved.14 The reported 70% reduction in SOP creation time means that training content can be developed, updated, and disseminated much more rapidly, ensuring that new and existing employees always have access to the latest best practices.

**III. The Bottom Line: ROI and Strategic Value of In-House AI Initiatives**

Evaluating the return on investment (ROI) and strategic value is paramount for SMBs considering in-house AI initiatives. While direct attribution can be complex, the evidence points towards substantial financial returns and significant strategic advantages.

**Table 2: Illustrative Case Studies of AI in Manufacturing/Operations with Reported Outcomes**

| **Company/Project Context** | **Primary AI Application** | **Key Quantitative Outcomes** | **Nature of Development** | **Relevance to SMBs (Potential)** | **Source(s)** |
| --- | --- | --- | --- | --- | --- |
| Global Food Manufacturer | Predictive Maintenance, Machine Utilization | $0.5M/week productivity savings, 5% output increase, reduced unplanned downtime | Vendor AI Platform (ThroughPut) | High impact on core operational metrics; principles of predictive maintenance and data analysis are scalable/adaptable. | 9 |
| BMW (Regensburg Plant) | Predictive Maintenance | >500 minutes disruption saved/year per plant | In-house Machine Learning | Demonstrates viability of in-house development for downtime reduction; SMBs can focus on critical assets. | 4 |
| Georgia-Pacific | Predictive Maintenance | 30% reduction in unplanned downtime | Leveraged AI Platform (SAS Viya on AWS) | Shows success with leveraging advanced platforms; SMBs can use similar cloud-based AI services. | 5 |
| Epiroc | Quality Control (Predicting Steel Properties) | 30% reduction in customer rejections/product returns | Leveraged AI Platform (Azure ML) | AI for quality improvement is highly relevant; SMBs can apply AI to critical quality parameters. | 5 |
| Siemens Gamesa | Quality Control (Defect Detection) | 25% reduction in defects, ROI expected in 2.5 years | Vendor-developed ML system (IBM) | Automated inspection principles are applicable; ROI timeframe provides a benchmark. | 5 |
| Leading Battery Manufacturer | Onboarding & Worker Productivity | 40% reduction in onboarding time, 17% worker productivity improvement | Vendor AI Platform (Augmentir) | Directly addresses onboarding efficiency, a key SMB concern. | 14 |
| SaaS Provider for Mfrs. | SOP Creation, Training & Productivity | 70% SOP creation time reduction, ~30% training cost & time-to-productivity reduction | Co-developed GenAI (Quantiphi/AWS/Claude V3) | AI for documentation and training material generation is highly valuable for SMBs to ensure consistency and speed. | 18 |
| Mid-sized Automotive Parts Manufacturer (BytePlus) | Demand Forecasting (Supply Chain Optimization) | 20% reduction in inventory costs, 15% improvement in delivery times | Vendor AI Platform (BytePlus ModelArk) | Demonstrates AI impact on supply chain efficiency, relevant for manufacturing SMBs managing inventory. | 31 |
| Food Processing Company (BytePlus) | Quality Control (Image Recognition) | 30% reduction in product recalls | Vendor AI Platform (BytePlus ModelArk) | AI for automated quality checks can significantly reduce costs and protect brand reputation for SMBs. | 31 |
| Skyhigh Security (Analogous to Info. Retrieval Needs) | Technical Document Search (Improving Support Efficiency) | Search time reduced from 3 hrs daily; Ticket resolution from 1.5 days to "few hours" | Vendor AI Agent (Odin AI) | Highly analogous to SMB manufacturing needs for quick access to SOPs, manuals, troubleshooting guides, impacting technician efficiency and MTTR. | 13 |

A. Quantifying Financial Returns: Cost Savings and Revenue Enhancement

The financial benefits of implementing AI, particularly internally leveraged knowledge systems, manifest primarily through direct cost savings and, often indirectly, through revenue enhancement.

Direct cost savings are frequently the most tangible and immediate returns. Predictive maintenance, a common AI application, can reduce overall maintenance costs by up to 40%.17 Improvements in FPY, driven by AI-powered quality control, lead to lower material waste and reduced labor costs associated with rework or scrap.25 AI-driven demand forecasting can optimize inventory levels, as seen in a mid-sized automotive parts manufacturer that reduced inventory costs by 20%.31 Similarly, AI in quality control helped a food processing company cut product recall costs by 30%.31 The significant productivity savings reported by a food manufacturer, amounting to USD 0.5 million per week due to downtime reduction, further underscore the potential for substantial cost avoidance.9

While an internal AI knowledge base or troubleshooting system might not directly generate sales, its impact on revenue can be realized through increased operational efficiency. For instance, the same food manufacturer that reduced downtime also saw a 5% increase in output due to smarter machine utilization facilitated by AI.9 More broadly, 91% of SMBs that have adopted AI report that it boosts their revenue.2 At a higher level of AI maturity, companies designated as "AI leaders" report tangible top-line benefits, including a 31% increase in revenue, a 22% growth in market share, and the development of new products and services (22%).32

The fundamental formula for calculating ROI is Net Profit divided by Investment Cost, multiplied by 100.33 For SMBs developing in-house AI tools, the investment cost must comprehensively include not only any initial software or platform licenses but also the significant cost of development staff time, specialized expertise (if hired or contracted), data acquisition and preparation efforts, and ongoing maintenance and training.33

For AI knowledge systems specifically, while direct revenue generation may be indirect (e.g., faster problem resolution leading to reduced production losses, which in turn protects revenue streams), the cost savings from increased efficiency are more immediately quantifiable. Reductions in information search time, faster onboarding of new staff, and fewer errors due to better access to accurate information all contribute to a stronger ROI calculation.33 SMBs are well-advised to initiate AI projects that target specific, high-cost operational pain points. Addressing these focused areas first is more likely to yield clear and rapid ROI, thereby building internal confidence and momentum for further AI investments.1 This is particularly salient given that a notable percentage of AI projects (around 40%) reportedly yield negative or no returns, especially in the early stages of adoption.32

B. ROI Timeframes: Real-World Examples and Estimation Frameworks

The timeframe to achieve a positive ROI on AI investments can vary significantly based on the project's scope, complexity, and the organization's AI maturity. Siemens Gamesa, for example, anticipates an ROI within 2.5 years for its comprehensive AI-driven defect reduction system.5 In contrast, some vendor solutions, like ThroughPut AI's platform, claim a much more rapid ROI, potentially under 90 days, although this is for a fully developed commercial product.9

General observations suggest that AI ROI is not always immediate. Firms in the earlier stages of AI adoption often experience flat results initially. It is typically when AI is scaled more widely across the enterprise that ROI figures begin to rise significantly, with average returns moving from around 1.5% for "advancing" firms to 4.3% for "AI leaders".32

For an SMB undertaking in-house AI development, several factors will influence the ROI timeframe. These include the complexity of the development effort, the specific problem being addressed, the quality and accessibility of existing data, the speed of user adoption, and the internal resources allocated.33 Setting clear, achievable timeframes and avoiding unrealistic expectations is crucial.33 SMBs often target, and benefit from, shorter ROI timeframes by focusing on high-impact, narrowly-scoped projects. Such "quick wins" can provide the necessary justification for continued and expanded AI investment. While a large enterprise like Siemens Gamesa might plan for a multi-year ROI on a substantial system, an SMB's internally developed "AI-assisted troubleshooting guide for a critical machine" might aim for a payback period of 6 to 12 months by demonstrably reducing downtime and repair costs for that specific asset.

A critical factor influencing the ROI timeframe for knowledge-based AI tools is the "knowledge refresh rate." If the underlying operational knowledge, procedures, or equipment specifications change rapidly, the AI tool must be designed for easy and efficient updates. Otherwise, its accuracy and utility diminish quickly, eroding its value and extending or even negating the ROI.12 An in-house system must therefore incorporate a strategy for ongoing knowledge maintenance and updates to ensure its long-term viability and return.

C. Beyond Direct ROI: Strategic Advantages and Competitive Edge

The value of internally developed or leveraged AI initiatives extends far beyond directly quantifiable financial returns. These tools can unlock significant strategic advantages and contribute to a sustainable competitive edge for SMBs. AI systems are capable of extracting novel insights and knowledge from operational data, presenting complex relationships and patterns in a manner that supports more informed human decision-making.8

The adoption of AI enhances organizational agility and resilience. It allows firms to respond more rapidly to changing customer demands, adapt to market shifts, and address process deviations with greater effectiveness.8 This ability to pivot and optimize in near real-time is a crucial competitive differentiator in dynamic markets.

AI-driven knowledge management systems play a vital role in knowledge retention and the prevention of knowledge loss, a particularly salient benefit as experienced members of the workforce approach retirement.26 By capturing and codifying tacit and explicit knowledge, these systems ensure that valuable operational expertise remains within the organization. Furthermore, well-designed AI systems are inherently scalable, capable of growing and adapting to meet evolving organizational needs and increasing data volumes.26 AI can also act as a catalyst for innovation within an organization by streamlining network communication, automating routine data management tasks, and freeing up human capital for more creative and strategic endeavors.8

A particularly potent strategic advantage for SMBs lies in the potential for internally developed AI knowledge tools to become unique competitive differentiators. While competitors might acquire similar machinery or off-the-shelf software, an SMB's decades of specific operational experience, accumulated troubleshooting know-how, and finely tuned proprietary processes represent a distinct and valuable asset. If an in-house AI tool can effectively capture, organize, and disseminate this internal "tribal knowledge," it creates an operational advantage in efficiency, quality, and problem-solving speed that is difficult for others to replicate.8

Finally, the very process of developing an in-house AI tool can cultivate valuable internal capabilities. Engaging in even small pilot projects serves to enhance AI understanding, data literacy, and process awareness within the SMB's team.15 As the team works to define requirements, gather and prepare data, and test and refine an internal AI solution, they invariably deepen their understanding of their own operations and data landscapes. This upskilling and accumulation of practical AI experience is a strategic asset in itself, positioning the SMB for future innovations and continuous improvement.

**IV. Navigating Implementation: Pathways and Considerations for SMBs**

Successfully implementing in-house AI knowledge systems requires careful planning and consideration of various pathways and critical success factors. SMBs can draw valuable lessons from diverse approaches, including commercial vendor solutions and large enterprise deployments, while also leveraging emerging trends like citizen development.

A. Learning from All Approaches: Insights from Vendor Solutions and Large Enterprises

While the goal may be an "in-house" solution, SMBs can significantly benefit from studying the functionalities, user experiences, and reported successes of commercial AI tools and large-scale AI deployments. These external examples can inform the design and scope of internal projects. Key features commonly found in effective commercial AI knowledge management and search tools include intelligent search capabilities, robust Natural Language Processing (NLP) for intuitive querying, automated content tagging for better organization, contextual recommendations to guide users, and predictive analytics for anticipating information needs.10 Even if an SMB implements these features in a simpler form, their inclusion addresses core user requirements for efficient information access.

The documented results from large companies, such as BMW's downtime reduction 4 or the battery manufacturer's onboarding time improvements 14, provide valuable benchmarks. These examples help SMBs set realistic, yet ambitious, goals for their internal AI projects, understanding what levels of impact are achievable.

Vendor solutions often represent best practices in user interface (UI) and user experience (UX) design, resulting from significant investment in research and development. SMBs developing their own tools should benchmark against these established usability standards. A powerful internal AI tool that is clunky, unintuitive, or difficult to use will likely face poor adoption and fail to deliver its potential benefits, regardless of its underlying technical sophistication.

The "build vs. buy" decision for SMBs is not always a binary choice. A hybrid approach can offer a pragmatic path to an "in-house" solution. This might involve using a vendor's core AI engine (such as a Large Language Model API from providers like OpenAI 11 or Google Palm2 utilized in some knowledge chat systems 12) as a backend for capabilities like search or question-answering. The SMB's internal development efforts can then focus on building a custom application layer, data connectors specific to their internal systems, and tailored knowledge ingestion processes. This strategy leverages powerful external AI capabilities while allowing the SMB to retain control over the application's specific functionality, user interface, and, crucially, its proprietary data.

B. The Rise of Citizen Development and Accessible AI Platforms for In-House Solutions

A significant trend democratizing the creation of AI tools is the rise of AI-powered citizen development platforms. These platforms are designed to enable users with minimal or no traditional programming skills—often business users or operational staff—to build and deploy applications.6 This is particularly relevant for SMBs that may have limited access to dedicated AI specialists or large software development teams. Such platforms typically provide tools for automating tasks, integrating data sources, and embedding data-driven insights into custom applications.

In a manufacturing context, citizen developers could potentially create applications for tracking supply chain elements, developing simple predictive maintenance alerts based on sensor thresholds, or building interactive interfaces for accessing Standard Operating Procedures (SOPs).6 An operations manager or a tech-savvy technician in an SMB could leverage an AI platform to build a mobile application providing real-time production data or a guided troubleshooting tool for common equipment issues.7

The benefits of this approach include a significantly reduced time to build and deploy applications, potentially from days or weeks to mere hours for simpler tools.6 This agility allows SMBs to respond quickly to evolving needs. Cost savings can also be realized by reducing the reliance on external IT resources or specialized developers for every custom tool. Furthermore, by automating routine tasks and providing intelligent suggestions, these platforms can enhance overall operational efficiency.6 While specific platforms are not deeply analyzed in the available research, the overarching concept involves using low-code/no-code development environments combined with accessible AI services. BytePlus ModelArk, for instance, is mentioned as offering user-friendly interfaces and scalable solutions tailored to SMBs 31, and tools like Microsoft Power Apps or Make.com are cited in the context of automation which can be enhanced with AI.35

These citizen developer platforms effectively lower the barrier to entry for "in-house" AI solutions, shifting the focus from complex AI algorithm coding to the configuration of pre-built AI services and the design of user-centric workflows.6 However, the success of AI tools created via citizen development is heavily dependent on the quality and capabilities of the underlying AI components within the platform, as well as the clarity with which the business problem is defined. Moreover, as more individuals gain the ability to create applications, robust governance frameworks, data security protocols, and quality assurance processes become critically important to manage risks such as data misuse or the proliferation of ineffective or problematic "shadow IT" applications.6

C. Critical Success Factors: Data Strategy, Phased Rollouts, and Change Management

Regardless of the development pathway chosen, several critical success factors underpin the effective implementation of in-house AI knowledge systems in SMBs.

First and foremost is a robust data strategy. The adage "garbage in, garbage out" is amplified in the context of AI; the quality, accuracy, and relevance of the data fed into an AI system directly dictate its performance and reliability.36 For an internal AI knowledge base, this means ensuring that source documents, databases, and other information repositories are well-curated, accurate, and consistently updated. Effective data governance—establishing policies, roles, and standards for data management—is essential.36 The internal effort to build an AI tool must therefore prioritize data preparation and ongoing data quality management.

A **phased implementation approach** is highly recommended, particularly for SMBs. Instead of attempting to build a comprehensive, all-encompassing AI system from the outset, it is more prudent to start with a smaller, well-defined project that addresses a specific, high-impact business problem.1 This allows the organization to gain experience, learn from initial challenges, demonstrate early successes and ROI, and then use these lessons to inform subsequent, potentially more ambitious, AI projects.

**Clearly defined objectives** are crucial. Before embarking on development, SMBs must establish specific, measurable, achievable, relevant, and time-bound (SMART) goals for their AI initiative.33 Vague aspirations like "improve efficiency" are insufficient. Instead, targets should be quantified, such as "reduce average equipment troubleshooting time by 20%" or "decrease new technician onboarding time by 15%."

**User training and adoption** are key to realizing the benefits of any new system. Even the most intuitive AI tools may require users to adapt their workflows. Providing adequate training and ongoing support is essential.37 For internally developed tools, involving end-users—such as technicians, support agents, or operators—early in the design, development, and testing phases can significantly improve buy-in and adoption rates. Their practical insights can also lead to a more effective and user-friendly tool.

Comprehensive **cost considerations** are vital. SMBs must accurately calculate all associated costs, not just the initial development or platform subscription fees. This includes the ongoing expenses of maintenance, data storage and processing, potential software updates, and the time investment required for training and data curation.33

Finally, **cybersecurity, data privacy, and ethical considerations** must be addressed from the project's inception.15 As AI systems handle potentially sensitive operational or employee data, ensuring robust security measures and adherence to privacy regulations is non-negotiable. Employee concerns about AI, such as job displacement or lack of transparency, also need to be proactively managed.15 Building trust in AI tools through clear communication, demonstrating their value as assistive technologies, and fostering a collaborative approach to their integration is as important as the technological development itself for ensuring successful implementation and achieving the desired ROI in an SMB environment.12

**V. Conclusion: Harnessing Internal AI for a Competitive Future**

The evidence strongly suggests that internally leveraged AI knowledge systems and similar AI tools offer significant, measurable benefits for manufacturing and operational SMBs. The journey towards AI adoption, while requiring careful planning and strategic execution, is becoming increasingly accessible and can yield substantial returns in efficiency, quality, and workforce proficiency.

SMBs have witnessed or can realistically project notable quantitative impacts. Downtime can be slashed by leveraging AI for predictive maintenance, with reductions of up to 50% observed in broader manufacturing contexts and specific successes like BMW saving over 500 minutes of disruption per plant annually through in-house models.4 This translates into direct cost savings and increased production capacity. First Pass Yield sees improvement through AI-driven defect detection and process optimization, with case studies showing defect reductions of 25-30%.5 For internal knowledge systems, the impact on information retrieval is profound; the potential to drastically cut down hours spent daily searching for technical documentation, as seen in analogous cases 13, directly translates to increased technician and operator efficiency. Furthermore, AI-powered training and onboarding solutions have demonstrated the ability to reduce onboarding time by figures around 40% and accelerate time-to-productivity by approximately 30% 14, addressing critical skills gap challenges.

For SMBs embarking on or scaling their in-house AI initiatives, several actionable recommendations emerge:

1. **Start with a Clear Business Problem:** Identify a specific, high-impact pain point where AI can deliver measurable value. Avoid overly ambitious initial projects; focus on a well-defined scope that allows for a tangible "quick win."
2. **Prioritize Data Strategy:** Recognize that high-quality, accessible, and well-governed data is the bedrock of any successful AI system. Invest in data preparation and establish processes for ongoing data maintenance.
3. **Explore Pragmatic Development Paths:** Consider leveraging citizen developer platforms or adopting a hybrid approach that combines vendor AI engines (e.g., LLM APIs) with custom-built application layers tailored to specific internal needs. This balances capability with resource constraints.
4. **Embrace User-Centric Design:** Involve end-users (technicians, operators, support staff) early and continuously in the design, development, and testing process. An intuitive and practical tool is more likely to be adopted and deliver results.
5. **Implement in Phases and Iterate:** Roll out AI solutions incrementally. Measure the impact of each phase, gather feedback, and use these learnings to refine the system and inform future development.
6. **Invest in Training and Change Management:** Proactively address employee concerns, provide thorough training on new AI tools and workflows, and foster a culture that views AI as an empowering assistant rather than a threat.

The future trajectory of AI in manufacturing and operations points towards even more powerful and accessible capabilities. Generative AI is set to revolutionize knowledge creation, summarization, and interaction.12 Multimodal AI, capable of processing and integrating information from diverse sources like text, images, and real-time sensor data, will provide richer and more holistic operational insights.39 Hyper-personalization will deliver information and assistance tailored to individual user needs and contexts.26 Furthermore, the increasing integration of AI with IoT devices and edge computing will enable more sophisticated real-time operational intelligence and autonomous decision-making capabilities within the manufacturing environment.34

These evolving trends are progressively lowering the barriers to entry for SMBs, enabling them to develop increasingly impactful in-house AI solutions. The shift is from AI primarily as a reactive information retrieval tool to a proactive, predictive, and ultimately collaborative operational assistant. By strategically harnessing these internal AI capabilities, manufacturing and operational SMBs can significantly enhance their efficiency, competitiveness, and resilience in an increasingly data-driven world.

VI. References

8

34

33

11

36

26

10

9

28

12

5

4

20

39

38

40

29

21

1

22

23

25

15

2

16

34

30

13

18

27

3

17

19

6

7

32

37

35

24

14

6

31

9

4

30

18

13

18

14

#### Works cited

1. How AI is transforming manufacturing and why AI-readiness matters, accessed May 25, 2025, <https://incit.org/en_au/thought-leadership/how-ai-is-transforming-manufacturing/>
2. New Research Reveals SMBs with AI Adoption See Stronger Revenue Growth - Salesforce, accessed May 25, 2025, <https://www.salesforce.com/news/stories/smbs-ai-trends-2025/>
3. Adopting AI could increase small business productivity by up to 133% - Enterprise Nation, accessed May 25, 2025, <https://www.enterprisenation.com/learn-something/adopting-ai-could-increase-small-business-productivity-by-up-to-133-per-cent/>
4. To Reduce Equipment Downtime, Manufacturers Turn to AI ..., accessed May 25, 2025, <https://biztechmagazine.com/article/2025/03/reduce-equipment-downtime-manufacturers-turn-ai-predictive-maintenance-tools>
5. 5 AI Case Studies in Manufacturing | VKTR, accessed May 25, 2025, <https://www.vktr.com/ai-disruption/5-ai-case-studies-in-manufacturing/>
6. How AI is Transforming Citizen Development - Kissflow, accessed May 25, 2025, <https://kissflow.com/citizen-development/ai-in-citizen-development/>
7. Exploring the Role of Citizen Developer in the AI Era - Aire AI App-Builder, accessed May 25, 2025, <https://aireapps.com/articles/exploring-the-role-of-citizen-developer-in-the-ai-era/>
8. The mediating role of knowledge management processes in the ..., accessed May 25, 2025, <https://www.emerald.com/insight/content/doi/10.1108/ijopm-05-2022-0282/full/html>
9. Case Study - AI in Food Manufacturing Cuts Downtime, Saves $0.5 ..., accessed May 25, 2025, <https://throughput.world/blog/ai-in-food-manufacturing-eliminates-downtime/>
10. AI Enterprise Search: Top Features and Tools in 2025 | Slack, accessed May 25, 2025, <https://slack.com/blog/productivity/ai-enterprise-search-top-features-and-tools-in-2025>
11. OpenAI's Deep Research: Unlocking Rapid ROI for SMB Owners and PE Rollups, accessed May 25, 2025, <https://proactivemgmt.com/blog/2025/02/04/openais-deep-research-unlocking-rapid-roi-for-smb-owners-and-pe-rollups/>
12. Revolutionise Knowledge Management in Your Company with AI - WEBSENSA, accessed May 25, 2025, <https://www.websensa.com/blog/company-knowledge-management-with-ai>
13. Using AI Agents For Technical Document Search: A Detailed Case ..., accessed May 25, 2025, <https://blog.getodin.ai/using-ai-agents-for-technical-document-search-a-detailed-case-study/>
14. How AI is Revolutionizing Manufacturing Training - Augmentir, accessed May 25, 2025, <https://www.augmentir.com/blog/how-ai-is-revolutionizing-manufacturing-training>
15. Study reveals high AI adoption in manufacturing sector - CohnReznick, accessed May 25, 2025, <https://www.cohnreznick.com/insights/manufacturing-checkup-artificial-intelligence>
16. Harmonising humans and technology: Exploring the dynamics of cognitive production, artificial intelligence and social communicat - Amazon S3, accessed May 25, 2025, [https://s3-eu-west-1.amazonaws.com/openreseurope/manuscripts/19903/2b8c4f41-39cb-4fdb-aa01-d77c7f92e062\_18418\_-\_stefan\_walter.pdf?doi=10.12688/openreseurope.18418.1&s3BucketUrl=https%3A%2F%2Fs3-eu-west-1.amazonaws.com%2Fopenreseurope&submissionUrl=%2Ffor-authors%2Fpublish-your-research&eaqKey=d58da3b4-052e-4210-8e27-0846e9398624&immUserUrl=https%3A%2F%2Fore-proxy.f1krdev.com%2Feditor%2Fmember%2Fshow%2F&numberOfBrowsableCollections=98&numberOfBrowsableInstitutionalCollections=0&numberOfBrowsableGateways=9](https://s3-eu-west-1.amazonaws.com/openreseurope/manuscripts/19903/2b8c4f41-39cb-4fdb-aa01-d77c7f92e062_18418_-_stefan_walter.pdf?doi=10.12688/openreseurope.18418.1&s3BucketUrl=https://s3-eu-west-1.amazonaws.com/openreseurope&submissionUrl=/for-authors/publish-your-research&eaqKey=d58da3b4-052e-4210-8e27-0846e9398624&immUserUrl=https://ore-proxy.f1krdev.com/editor/member/show/&numberOfBrowsableCollections=98&numberOfBrowsableInstitutionalCollections=0&numberOfBrowsableGateways=9)
17. AI in Manufacturing: Automation Growth and Industry Stats You Can't Ignore | PatentPC, accessed May 25, 2025, <https://patentpc.com/blog/ai-in-manufacturing-automation-growth-and-industry-stats-you-cant-ignore>
18. Empowering Secure & Scalable SOP Creation with Gen AI for a ..., accessed May 25, 2025, <https://quantiphi.com/case-studies/empowering-secure-scalable-sop-creation-with-gen-ai-for-a-saas-platform/>
19. Use AI to Boost Operational Efficiency in your Business | TTMS, accessed May 25, 2025, <https://ttms.com/boost-operational-efficiency-with-ai-speed-up-your-business/>
20. Downtime in Manufacturing- AI to the Rescue - UptimeAI, accessed May 25, 2025, <https://www.uptimeai.com/resources/downtime-in-manufacturing-ai-to-the-rescue/>
21. How AI-Driven Preventive Maintenance Eliminates Downtime & Saves Millions, accessed May 25, 2025, <https://www.innovapptive.com/blog/how-ai-driven-preventive-maintenance-eliminates-downtime-saves-million>
22. How Generative AI Can Help Reduce Resolution Time - Workativ Assistant, accessed May 25, 2025, <https://workativ.com/ai-agent/blog/generativei-ai-reduce-resolution-time>
23. Learn How to Apply AI to Maximize First Pass Yield in Electronics Manufacturing - Quality Line, accessed May 25, 2025, <https://quality-line.com/learn-how-to-apply-ai-to-maximize-first-pass-yield-in-electronics-manufacturing/>
24. Artificial intelligence in lean manufacturing: digitalization with a human touch? | Emerald Insight, accessed May 25, 2025, <https://www.emerald.com/insight/content/doi/10.1108/ijlss-05-2024-256/full/pdf?title=artificial-intelligence-in-lean-manufacturing-digitalization-with-a-human-touch>
25. First Pass Yield: Calculation, Examples and Improvement Strategies - SCW.AI, accessed May 25, 2025, <https://scw.ai/blog/first-pass-yield/>
26. AI in Knowledge Management: Benefits, Concerns and Future - Aisera, accessed May 25, 2025, <https://aisera.com/blog/ai-knowledge-management/>
27. AI in manufacturing: Transforming engineering, production and ..., accessed May 25, 2025, <https://blogs.sw.siemens.com/tecnomatix/ai-in-manufacturing-transforming-engineering-production-and-supply-chains/>
28. AI and Knowledge Management: Best Practices and Real-World Examples - Botscrew, accessed May 25, 2025, <https://botscrew.com/blog/ai-and-knowledge-management/>
29. Onboarding Made Easy: Streamlining New Worker Safety in Manufacturing with AI - HSI, accessed May 25, 2025, <https://hsi.com/blog/ai-manufacturing-onboarding-safety>
30. The Impact of AI on Onboarding Software: Enhancing User ..., accessed May 25, 2025, <https://psico-smart.com/en/blogs/blog-the-impact-of-ai-on-onboarding-software-enhancing-user-experience-and-efficiency-170821>
31. What is the ROI of AI for Manufacturing? - BytePlus, accessed May 25, 2025, <https://www.byteplus.com/en/topic/534268>
32. Driving ROI Through AI - Econsult Solutions, accessed May 25, 2025, <https://econsultsolutions.com/wp-content/uploads/2020/09/ESITL_Driving-ROI-through-AI_FINAL_September-2020.pdf>
33. How to measure and generate ROI with AI: An actionable guide - Dialpad, accessed May 25, 2025, <https://www.dialpad.com/blog/roi-with-ai/>
34. (PDF) AI impacts on supply chain performance : a manufacturing use case study, accessed May 25, 2025, <https://www.researchgate.net/publication/370540338_AI_impacts_on_supply_chain_performance_a_manufacturing_use_case_study>
35. Data platform: its role in data ecosystem and reporting automation - Automaize, accessed May 25, 2025, <https://www.automaize.pl/en/blog/reporting-automation-6/data-platform-vs-reporting-automation-34>
36. Data Quality Metrics for Enterprise AI Models - Alation, accessed May 25, 2025, <https://www.alation.com/blog/data-quality-metrics-enterprise-ai-models/>
37. AI + No-Code: The Winning Formula for Business Success - Jestor, accessed May 25, 2025, <https://blog.jestor.com/ai-no-code-the-winning-formula-for-business-success/>
38. Measuring the productivity impact of AI coding tools: A practical guide for engineering leaders | Swarmia, accessed May 25, 2025, <https://www.swarmia.com/blog/productivity-impact-of-ai-coding-tools/>
39. Five manufacturing trends being reshaped by AI | Google Cloud Blog, accessed May 25, 2025, <https://cloud.google.com/blog/topics/manufacturing/five-manufacturing-trends-being-reshaped-by-ai>
40. Federally Funded Research Explores How AI Tools Can Improve Manufacturing Worker Safety, Product Quality | Kellogg Institute For International Studies, accessed May 25, 2025, <https://kellogg.nd.edu/news/federally-funded-research-explores-how-ai-tools-can-improve-manufacturing-worker-safety-product>