

A Forrester Total Economic Impact™  
Study Commissioned By IBM  
March 2021

# The Total Economic Impact™ Of IBM And Red Hat For Manufacturing

How Customers Unlocked Business Value  
With IBM And Red Hat

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# Executive Summary

## Key Benefits Of Using IBM And Red Hat Solutions Together



Business acceleration benefits of **\$233 million**



Business continuity benefits of **\$20 million**



Application development efficiencies of **\$42 million**



Infrastructure management efficiencies of **\$87 million**

For most of history, manufacturers have succeeded or failed on the quality with which they could produce physical goods. Today, that's no longer good enough. Manufacturing has become increasingly democratized, with lower cost competition that continues to erode margins. Objects and machines are connected and increasingly bundled with services, forcing manufacturers to develop new capabilities.

To compete in this new era, manufacturers must leverage technology to win and serve customers. Yet, not all manufacturing leaders are focused on modernization efforts: Only 36% of global technology purchase influencers report accelerating the shift to digital business as a high priority for their organizations. In 2021, Forrester expects to see more manufacturers shift their focus to modernization efforts, owing to the impact and level of disruption that the COVID-19 pandemic had on supply chains and staffing during a time when demand surged for many manufacturers.<sup>1</sup>

Manufacturers that succeed will prioritize technology investments that enable technical teams to move faster, deliver innovative products, and shift toward service-based business models. They will connect machines, applications, and people across their environments and develop ecosystems of value that include partners, customers, and suppliers. Moving data from the factory edge to the extended enterprise will inform rapid decision-making and continuous improvement initiatives.

Importantly, few manufacturers are in a position to start anew when it comes to the technology infrastructure that powers their businesses. Amid modernization efforts, manufacturers still need to provide their customers with great experiences, but scaling digital transformation efforts can be a risky business. In order to balance this risk, manufacturers should adopt a strategy of continuous improvement that focuses on quick, pragmatic projects which have demonstrable value to the customer.<sup>2</sup> And to succeed, manufacturers should seek technology vendors that enable them to achieve results through modular deployments while ensuring business continuity.

IBM and Red Hat provide a portfolio of products that enable manufacturers to deploy application workloads in open hybrid environments, ranging from private, to public clouds, to edge locations. Containerized, prepackaged solutions enable consistency and scalability by streamlining workflows for developers and administrators and speeding time-to-value for the business.

**Methodology.** IBM commissioned Forrester Consulting to conduct a Total Economic Impact (TEI) study and examine the potential return on investment (ROI) manufacturing firms may realize by using solutions from IBM and Red Hat together to modernize their businesses. The purpose of this study is to provide readers with a framework to evaluate the potential financial impact of using IBM and Red Hat solutions together at their own organizations.

“The future state of a completely connected enterprise is what’s driving our investments. Today, the success of a manufacturing organization is determined by how effectively machines, applications, employees, partners, suppliers, and customers work together.”

*Senior operations director,  
global electronics manufacturer*



To illustrate the financial impact of using IBM and Red Hat solutions together — including the benefits, flexibility, costs, and risks of an investment — Forrester designed a sample organization that is representative of five interviewed manufacturing firms. The findings are directly based on interviewed customers’ experiences.

### Primary Data Sources For Forrester’s Financial Analysis



- **Interviews with 5 global manufacturing firms as well as 20 organizations in other industries** using solutions from IBM and Red Hat together.
- **Twenty Forrester TEI studies with over 60 interviewed customers** published between 2018 to 2020 examining specific IBM or Red Hat solutions.
- **Annual reports and financial disclosures** for leading publicly traded companies in manufacturing.
- Forrester’s comprehensive market research.

“We use OpenStack as a development environment for all of our custom applications, including our MES [manufacturing execution system]. We’re also using Red Hat as our platform for developing solutions and services for industrial IoT.”

*Executive lead for IoT, AI, and analytics, industrial equipment manufacturer*



The sample manufacturer has a global presence, with its headquarters in North America. It earns \$60 billion in annual revenues and employs approximately 200,000 workers, with 80% of those employees in frontline roles. Using IBM and Red Hat solutions and services, it undertakes a four-year technology transformation in which it: 1) deploys a hybrid multicloud container platform based on Red Hat Enterprise Linux (RHEL), Red Hat OpenShift, and IBM Cloud Paks across an IBM and third-party public and private cloud environment; 2) modernizes existing applications; 3) migrates workloads to IBM Cloud and third-party cloud platforms; 4) leverages modern architectures to support application development and maintenance productivity; 5) integrates and rationalizes data from across the enterprise; and 6) improves quality in manufacturing operations through the deployment of asset performance management (APM), AI and machine learning (ML), and edge analytics.

### Key Findings

Interviewed manufacturers described how investments in modernization with IBM and Red Hat solutions enabled them to improve operations, eliminate costs, and ensure customer satisfaction. By building on a hybrid, multicloud platform from IBM and Red Hat, interviewed organizations reduced costs for technology and labor to maintain and support technology infrastructure; these savings include costs to integrate and understand data from across the enterprise. With the elimination of cumbersome technologies and manual, repetitive work, manufacturers improved the employee experience for developers, IT administrators, and analysts, ultimately making them more productive as well. Interviewed organizations reported significant improvements in throughput for new and existing software applications. At manufacturing sites, manufacturers deployed APM, AI and ML, and edge computing solutions from IBM and Red Hat to improve quality, reduce materials costs, and ensure uptime of critical operations.



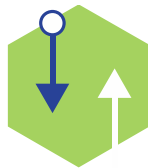
**ROI**  
**42%**



**Benefits PV**  
**\$780 million**



**NPV**  
**\$231 million**



**Payback**  
**25 months**

“For every dollar that we spend on the IBM Cloud and IBM Cloud Pak for Data, we save about \$6 on technology, development, and training. We’re also seeing faster time-to-insight and time-to-value.”

*Global VP for AI and cloud, consumer electronics and telecommunications equipment manufacturer*



**Synopsis.** Forrester’s financial analysis found that the sample manufacturer realized incremental benefits of \$780 million over five years versus incremental costs of \$549 million by modernizing with solutions from IBM and Red Hat, resulting in a net present value (NPV) of \$231 million, a payback period of 25 months, and an ROI of 42%.

**Quantified benefits.** Forrester modeled the total benefits of \$780 million over five years for the sample manufacturer, and they are as follows:

- › Business acceleration benefits including predictive maintenance and monitoring for equipment; enhanced product quality monitoring; and inventory optimization.
- › Business continuity benefits including reductions in downtime as well as enhanced security and compliance.
- › Application development and maintenance productivity including faster time-to-value for new applications and ease of management for containerized legacy applications.
- › Infrastructure cost efficiency for labor benefits including reallocating admins for infrastructure, middleware, and platform operations due to increased efficiency.
- › Infrastructure cost efficiency for technology benefits including cost avoidance for legacy hardware refreshes; better utilization of legacy hardware; and cost optimization for cloud resources.

**Unquantified benefits.** Interviewed organizations also described the following benefits that were unique to their business that they could not yet quantify:

- › Improved productivity for frontline workers, owing to increased reliability of operations.
- › Enhanced business agility, which enables organizations to better respond to unexpected events and changes in market conditions.
- › Improved supply chain health, owing to better integration and sharing of data across the enterprise and with suppliers and partners.
- › Improved customer understanding through integrated and complete data.

**Flexibility.** By modernizing with technologies from IBM and Red Hat, customers also gained the flexibility to respond more rapidly to disasters, capture opportunities in a quickly evolving marketplace, and deploy new technologies. Interviewees described how they aggregate data from across the enterprise to develop, test, and manufacture products to serve customers and win against competitors. Agile workflows, enabled by investments in hybrid, multicloud platforms, enable the delivery of internet-connected services to customers, such as connected car experiences. Interviewees also described how platforms built on IBM and Red Hat solutions enable experimentation and deployment of new technologies, including AI/ML, blockchain, internet of things (IoT), and APM.

**Costs.** Forrester modeled the total incremental costs of \$548 million over five years for the sample manufacturer, and they are as follows:

- › Technology costs for cloud, software, and AI and IoT capabilities.
- › Professional services costs for transformation, management, and support.
- › Training costs for technical and business staff.

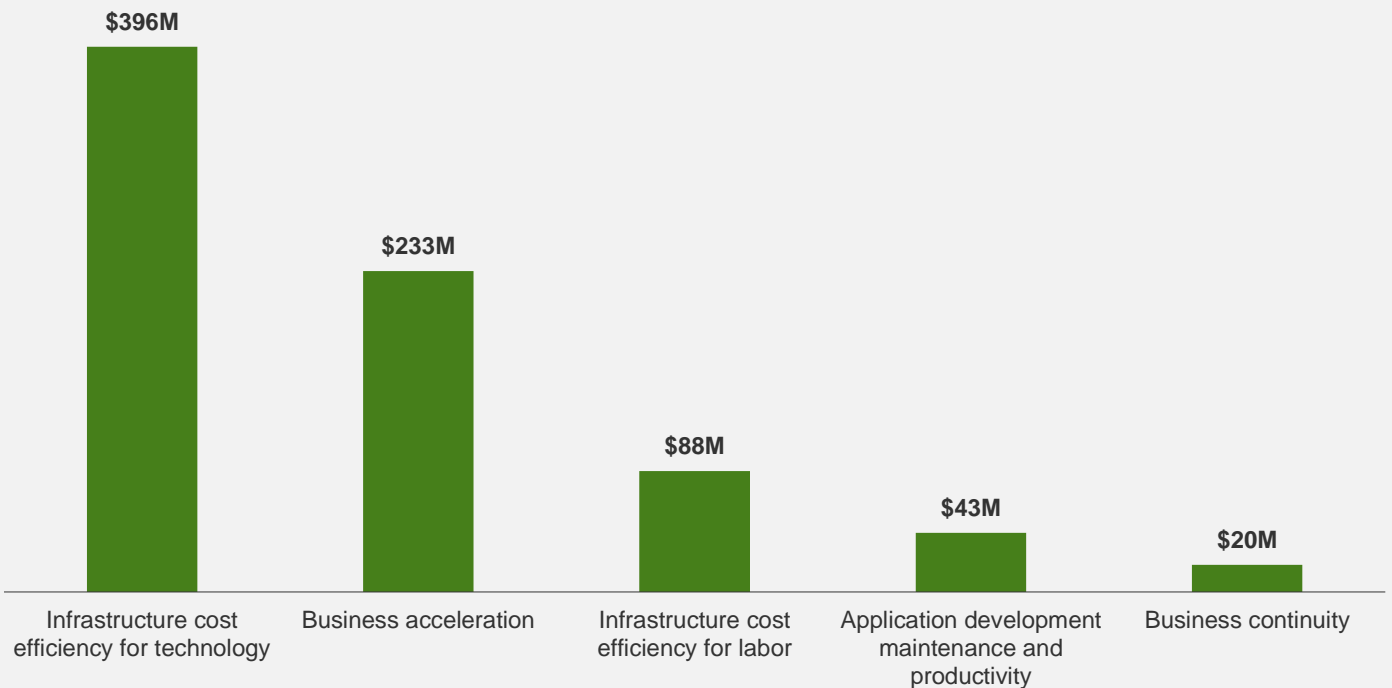
“The size of our team hasn’t really changed, but we’re doing much more than before. Our run rate has gone up by millions of units, our quality has improved, and we’re better able to forecast demand and deliver on time to our customers.”

*SVP and CIO, industrial, high technology equipment manufacturer*



**Risks.** Forrester has applied a risk adjustment to all financial metrics reported in this study to account for the inherent difficulty in isolating the benefits associated with a complex technology investment. While all calculations are informed by metrics reported by customers using IBM and Red Hat solutions in tandem, there are many factors that influence the magnitude of benefits realized by any one organization. Among these factors are legacy technologies, organizational capabilities, organizational scale, and market trends. Therefore, risk adjustments serve to produce conservative estimates of the financial impact of an investment in IBM and Red Hat solutions.

### Five-Year Benefits For The Sample Manufacturer (Risk-Adjusted Present Values)





Forrester's TEI methodology helps organizations understand, evaluate, and communicate the business impact of any investment.

## TEI Framework And Methodology

From the information provided in the interviews, Forrester has constructed a Total Economic Impact™ (TEI) framework for those organizations considering implementing solutions from IBM and Red Hat together.

The objective of the framework is to identify the cost, benefit, flexibility, and risk factors that affect the investment decision. Forrester took a multistep approach to evaluate the impact that using solutions from IBM and Red Hat together can have on an organization:



### **DUE DILIGENCE**

Interviewed IBM and Red Hat stakeholders and Forrester analysts to gather data relative to IBM and Red Hat.



### **CUSTOMER INTERVIEWS**

Interviewed 25 organizations using IBM and Red Hat to obtain data with respect to costs, benefits, and risks.



### **MULTI-STUDY DATA REVIEW**

Reviewed findings from 18 recent Forrester Consulting studies of IBM and Red Hat solutions, encompassing over 60 interviews and hundreds of survey respondents.



### **COMPOSITE ORGANIZATION**

Designed a composite organization based on characteristics of the interviewed organizations.



### **FINANCIAL MODEL FRAMEWORK**

Constructed a financial model representative of the interviews using the TEI methodology and risk-adjusted the financial model based on issues and concerns of the interviewed organizations.



### **CASE STUDY**

Employed four fundamental elements of TEI in modeling IBM and Red Hat's impact: benefits, costs, flexibility, and risks. Given the increasing sophistication that enterprises have regarding ROI analyses related to IT investments, Forrester's TEI methodology serves to provide a complete picture of the total economic impact of purchase decisions. Please see Appendix A for additional information on the TEI methodology.

## DISCLOSURES

Readers should be aware of the following:

This study is commissioned by IBM and delivered by Forrester Consulting. It is not meant to be used as a competitive analysis.

Forrester makes no assumptions as to the potential ROI that other organizations will receive. Forrester strongly advises that readers use their own estimates within the framework provided in the report to determine the appropriateness of an investment in IBM and Red Hat.

IBM reviewed and provided feedback to Forrester, but Forrester maintains editorial control over the study and its findings and does not accept changes to the study that contradict Forrester's findings or obscure the meaning of the study.

Interviews with eight of the 15 customers were sourced directly by Forrester without the involvement of IBM, with the other seven customer names provided by IBM. Neither IBM nor Red Hat participated in any of the 15 interviews.

# Market Trends

## MANUFACTURERS MODERNIZE FOR A NEW ERA

Manufacturing has undergone one of its most tumultuous phases in recent history with the disruption of the global economy due to the COVID-19 pandemic. It has laid bare the differences and dependencies of organizations that had modernized, diversified, and prepared with technology and flexibility for disruption. One of the striking outcomes of the pandemic was the unpredictable and befuddling shortages of many consumer and manufacturing goods due to the disruption of the supply chain. Consumers may never forget the shortages and the extraordinary demand for other basic supplies that emptied store shelves for extended periods.

Going forward, manufacturers must invest in technologies that enable them to adapt faster to rapidly changing conditions, whether that means ensuring business continuity amid supply chain and workforce disruptions or taking advantage of new technologies such as augmented reality and energy-efficient recycling.

- › **COVID-era acceleration of key emerging technologies will become a method of sustained adaptive innovation.** If it was not already a point of emphasis, flexibility and resilience became top priorities for manufacturers that may have previously focused on controlling costs and maximizing predictability and efficiency. Many of the impediments for manufacturers to adopt new technologies quickly dissipated as the reality of operating under COVID-era parameters set in. As one interviewee commented, “Manufacturing leaders will preserve the creativity they unlocked in 2020, making it their new normal.”
- › **Smart manufacturing technologies are necessary to modernize.** Forrester identified 20 technologies that are supporting the smart manufacturing landscape, six of which are identified as areas of investment for manufacturers due to their high business value and maturity. These include: APM software, digital twin, edge computing, industrial IoT software platforms, location-based tracking systems, and AL and ML. Smart manufacturing technologies, particularly when deployed in combinations, enable organizations to drive down costs while increasing connection with customers, suppliers, and partners. As stated by an interviewee, “[This] powers new business models that combine excellence in the manufacture of physical objects with excellence in interpreting and acting upon data-driven insights about those objects and their use.”
- › **IoT adds incremental benefits across the supply chain.** Manufacturing organizations are gaining incremental improvements through IoT technology enhancements that target specific pain points and processes. These improvements are modernizing the supply chain with a targeted purpose. This may include tracking technologies for transportation fleets, inventory and warehouse management solutions, and track-and-trace solutions for perishable or time-sensitive supplies. One interviewee stated: “The pandemic has exposed vulnerabilities in the lean supply chain approach, forcing companies to increase local inventory levels and diversify their suppliers. Instead of using a conventional linear supply chain, firms are deploying dynamic, integrated supply networks, which provide organizations with real-time insight across the entire supply network and give supply chain stakeholders the flexibility to address unforeseen disruptions and environmental challenges that impact product supply and demand.”
- › **Manufacturing practices that improve customer experience (CX) through a digital supply chain.** Consumers expect low prices and fast availability of inventory; this expectation has seeped into B2B purchase behavior. The quality of CX depends on your digital supply chain’s effectiveness in orchestrating supplier and fulfillment partnerships to meet anticipated demand at a price the customer will pay. Manufacturing organizations which are committed to improving CX will be positioned to take advantage of today’s consumer purchasing behavior. Adaptability and effectiveness in the digital supply chain are key indicators of the organizations’ ability to experience high revenue growth and high inventory turnover.
- › **Manufacturers can no longer ignore sustainability.** Companies of all sizes are taking on corporate responsibility and sustainability initiatives as among their highest priorities. In 2021, manufacturers can no longer ignore a mandate to create more sustainable businesses — customer trust and goodwill are at risk. Technology investments will play an important part in developing efficient, sustainable operations.



# Customer Journey

## CUSTOMERS' DRIVERS FOR IBM AND RED HAT INVESTMENTS

### Interviewed Organizations

Forrester interviewed five global manufacturing firms that are customers of both IBM and Red Hat to learn about their experiences utilizing solutions from both companies in tandem.

- › Interviewed organizations employ between 150,000 and 385,000 FTEs; on average, approximately 80% of these employees work in frontline positions.
- › All interviewed organizations have a global presence, with manufacturing sites throughout the world.
- › Two of the interviewed organizations manufacture consumer- and commercial-grade electronics, including telecommunications and automotive electronic equipment.
- › Two of the interviewed organizations produce equipment and software used in an array of industrial applications, including: consumer products, printing and publishing, chemicals manufacturing, oil and gas, and healthcare and precision medical applications.
- › One of the interviewed organizations is an automotive manufacturer.

Forrester has also integrated data from the following sources:

- › Twenty interviews with companies outside the manufacturing sector using IBM and Red Hat solutions in tandem.
- › Findings from more than 20 recent Forrester Consulting studies on the business value of specific IBM and Red Hat solutions.
- › Annual reports and financial disclosures for global manufacturing firms.
- › Forrester's comprehensive market research.

### Key Challenges

Interviewed companies faced common pressures from legacy infrastructure, strict compliance and security demands, poor software experiences, and rising marketplace competition.

- › **Downtime for IT and operations.** Prior to developing a robust quality monitoring program, that is largely enabled by IBM Cloud Paks for Data, Integration, and Automation, a global manufacturer of electronics and telecommunications equipment struggled to deliver 100% uptime to customers who were using its capital-intensive equipment. When equipment failed, high costs would result for both the manufacturer and its customers, since individual components needed to be produced, sourced, and replaced in remote field locations.
- › **Complex legacy systems.** Prior to engaging IBM and Red Hat to assist in modernizing its business, an automotive manufacturer struggled with dozens of cumbersome, legacy systems. The digital transformation director told Forrester, "Our systems were costing us a lot to maintain and run, and we weren't seeing the efficiency and productivity that we needed from them." This interviewee's technology environment was also ill-suited to support the development of digital, connected services and experiences that car buyers expect today.

Interviewed manufacturing customers used a range of the following solutions:

#### IBM

Blockchain  
Cloud  
Cloud Pak for Applications  
Cloud Pak for Data  
Cloud Pak for Integration  
Cloud Pak for Multicloud Management  
Cloud Private  
Db2  
Garage  
Maximo  
MQ  
Services  
Watson  
WebSphere Liberty  
Z Systems

#### Red Hat

Ansible  
Consulting  
Container Adoption Program  
Enterprise Linux (RHEL)  
Gluster Storage  
Insights  
JBoss EAP  
JBoss Web Server  
Open Innovation Labs  
OpenShift  
OpenStack Platform  
Satellite  
Virtualization

- › **Untapped, siloed data stores.** Before engaging IBM and Red Hat to streamline its data processes, a global manufacturer of electronics and telecommunications equipment invested heavily in a cloud data platform from an alternative provider. However, the manufacturer's highly qualified data scientists were still spending up to 80% of their time cleaning data for analysis. And subsequently, these costs of transforming, storing, and retrieving data far exceeded initial expectations.
- › **High maintenance costs for factory equipment.** Prior to implementing IBM Maximo, a global electronics manufacturer routinely replaced tooling on its assembly lines long before the end of its useful life. If they instead chose to wait, they would save on tooling costs but ultimately risk failures, which could result in the production of thousands of defective products before errors were caught. Across its 20,000 machines, the costs of early replacements added up to millions of dollars.

"RHEL powers our entire manufacturing footprint, and the reason it's so impressive is that it's an open standard. All of our deployments today are containerized, and we can deploy containers at the edge. Moving data from the edge, to one of our cloud platforms is seamless."

*Senior operations director,  
electronics manufacturer*



## Partner Selection

The interviewed organizations searched for partners that could:

- › **Deliver flexibility in a multicloud environment.** Interviewed organizations chose solutions like RHEL and OpenShift so they could work across any infrastructure and unify private and public cloud environments. They sought the flexibility to place workloads in their optimal environment, considering changing costs and capacity requirements, without being locked in to any one vendor.
- › **Support for modern development workflows.** Interviewed organizations sought to streamline application development and maintenance workflows to increase throughput and to innovate faster. Legacy technology stacks, which had been cobbled together over several decades held them back. They sought a partner that could assist them in adopting new ways of working, including agile, DevOps, and continuous integration and testing methodologies.
- › **Support for an enterprisewide modernization effort.** Interviewed organizations sought a partner that could support broad-based digital transformation goals and Industry 4.0 initiatives. Among key goals for manufacturers were streamlining productivity for IT and operations teams; integrating, rationalizing, and understanding data from across the enterprise, from customer data to factory production data; and improving manufacturing throughput and quality through predictive monitoring and maintenance and edge deployments of AI/ML.
- › **Support for pragmatic, continuous improvement.** Looking back, interviewed organizations completed large-scale transformations. However, these enterprisewide transformations comprised a series of smaller projects, with each focused on a specific business outcome. As such, they sought a partner that would assist in maximizing existing investments, while delivering against pragmatic goals for modernization.
- › **Deliver comprehensive professional services and support informed by industry expertise and experience.** Interviewed organizations sought partners with proven industry expertise, and that could accelerate time-to-value through professional services focused on strategy, planning, and adoption.
- › **Support for future innovations.** Interviewed organizations wanted a technology partner that could provide a foundation that could support

"Across our global operations, we use multiple cloud providers. We are standardizing on OpenShift and the IBM infrastructure, which means our developers can build something once, and then deploy to any cloud that we use across geographies and customers."

*Global VP of cloud and AI,  
electronics and wireless  
equipment manufacturer*



future requirements. Since requirements for vendors, customers, and product teams inevitably change, they sought the flexibility of a hybrid cloud solution based on open source technologies.

## IBM And Red Hat Capabilities

Companies that Forrester interviewed have invested in the following offering categories from IBM and Red Hat:

- › **Professional services.** IBM Services, IBM Garage, Red Hat Container Adoption Program, and others helped set strategy and taught companies to leverage modern containerization, microservices, and serverless architectures, despite technical debt and stringent security and compliance needs.
- › **Hardware.** IBM Z and IBM Power Systems boosted security, performance, and value, as compared to legacy hardware.
- › **Cloud.** IBM Cloud allowed customers to access the flexibility and value of the cloud, while meeting security and compliance needs.
- › **Platform.** Red Hat Enterprise Linux, Red Hat OpenShift, and IBM Cloud Paks provided the technology to consistently develop, monitor, and manage modern and legacy applications across hybrid and multicloud infrastructures (both IBM and third party).
- › **Middleware and services.** Organizations used prepackaged, containerized software from IBM and Red Hat catalogs including IBM WebSphere Liberty, Db2, MQ, Watson, or Blockchain and Red Hat Virtualization, Ansible, Insights, Gluster Storage, or JBoss.
- › **Asset performance management.** Organizations used the IBM Maximo Application Suite for intelligent asset management, monitoring, and predictive maintenance.

“The IBM Cloud Paks for Data and Integration have been critical to eliminating data silos across our organization. Previously, the data was there, but we couldn’t easily move it around, and we had a lot of manual processes. The Cloud Paks helped us to consolidate our data and develop collaborations across systems and business units.”

*Executive lead for IoT, AI, and analytics, industrial equipment manufacturer*



# Manufacturing Model

## Composite Organization

To model the Total Economic impact of investing in solutions from IBM and Red Hat for manufacturers, Forrester aggregated findings from interviews with five global manufacturers and 21 other companies across a range of industries to design a composite organization and an associated ROI analysis. This composite organization will be referred to as the sample manufacturer for the remainder of the study.

The sample manufacturer has a global presence with a headquarters in North America, and it:

- › Employs approximately 200,000 employees, with approximately 80% of employees in frontline roles. This translates into: 750 FTEs in IT and operations and 2,100 FTEs in development and data across North America and regional-market locations.
- › Earns approximately \$60 billion in revenue annually with a 5% net profit margin.
- › Spends approximately 1.6% of revenues on IT. Approximately 30% of the total IT budget is allocated to hardware and infrastructure, including cloud technology.
- › Owns and leases 50 manufacturing sites across the globe, comprising of more than 75 million square feet of production space.
- › Leverages multiple third-party clouds, which is required to support the business, owing to both customer and data protection and sovereignty requirements.

## Modeled Deployment

The sample manufacturer executes a four-year technology modernization strategy (with a five-year economic analysis). This includes: data center redesign and optimization; cloud and application modernization; adopting agile and DevOps workflows; deploying APM and AI/ML for factory operations.

The sample manufacturer deploys the following key technologies as part of a broader effort to standardize on IBM and Red Hat solutions:

- › **Red Hat Enterprise Linux with Red Hat OpenShift, IBM Cloud Pak for Applications, IBM Cloud Pak for Multicloud Management, and IBM Cloud Pak for Data** to form a private cloud that includes its modern and legacy data centers, its IBM Cloud environment, and a third-party public cloud environment.
- › **IBM Maximo** for inventory optimization and predictive maintenance and monitoring.
- › **IBM Cloud Pak for Integration** to create a robust, enterprisewide data architecture that ensures communication among applications, machines, employees, customers, and partners.

Additionally, the sample manufacturer:

- › Partners with **IBM Services** to: 1) strategize, plan, and conduct its data center transformation; 2) support adoption of IBM Cloud; 3) implement Red Hat Enterprise Linux, Red Hat OpenShift, IBM Cloud Paks, and containerized IBM middleware while navigating technical debt; and 4)

Financial modeling is based on customer data. Modeled impacts are shown for the most common, consistent solution combinations shared by interviewed customers.

Benefit and summary sections summarize all of the important elements for the calculation, but they omit the full tables to avoid excessive length. Calculation tables are available upon request.

“We’ve boosted product quality and manufacturing efficiency through the combination of edge computing and AI and machine learning. We’re bringing data and analytics closer to the production process.”

*CIO, industrial, high technology equipment manufacturer*



design best practices for modernization to ensure security, compliance, performance, and agility.

- › Utilizes the **Red Hat Container Adoption Program** to teach DevOps teams to use containers and microservices to their potential, helping modernize existing applications and develop new ones.
- › Engages **IBM Garage** for ideation and design of new apps that leverage AI/ML and edge capabilities from IBM, Red Hat, and the open source marketplace.

# Analysis Of Benefits

## QUANTIFIED BENEFIT DATA AS APPLIED TO THE COMPOSITE

Total Benefits						
BENEFIT	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	PRESENT VALUE
Business acceleration	\$55,821,991	\$60,991,343	\$62,375,491	\$65,165,031	\$65,629,312	\$233,276,195
Business continuity	\$2,185,226	\$4,703,114	\$6,079,414	\$6,821,234	\$7,563,481	\$19,796,314
Application development and maintenance productivity	\$4,681,664	\$9,469,408	\$13,337,792	\$16,746,496	\$15,063,360	\$42,894,139
Infrastructure cost efficiency for labor	\$7,009,313	\$17,959,172	\$26,156,107	\$34,456,150	\$37,555,335	\$87,718,786
Infrastructure cost efficiency for technology	\$38,974,665	\$71,192,532	\$106,334,390	\$150,251,329	\$192,187,913	\$396,116,170
<b>Total benefits (risk-adjusted)</b>	<b>\$108,672,858</b>	<b>\$164,315,569</b>	<b>\$214,283,194</b>	<b>\$273,440,240</b>	<b>\$317,999,401</b>	<b>\$779,801,604</b>



## Business Acceleration

**Benefit summary.** Manufacturing firms' investments in solutions from IBM and Red Hat enabled them to better serve and retain customers, resulting in direct improvements to operating margins. Interviewed organizations leveraged IBM Cloud Paks for Data and Integration to capture, understand, and integrate data from operations, partners, and suppliers. Predictive maintenance and monitoring, supported by the application of AI/ML at the edge, enabled organizations to optimize the useful lifetime of machinery and to reduce defect rates, resulting in lower costs and higher margins. However, by improving quality and reliability in manufacturing operations, interviewed organizations also saw higher satisfaction among customers.

**Impact to manufacturers.** For manufacturers, reducing costs, waste, and inefficiency are critical to success in today's hyper-competitive environment.<sup>3</sup> Interviewed organizations described how investments in advanced analytics programs, AI/ML, and APM with IBM and Red Hat enabled them to improve quality, optimize factory operations, and reduce the cost of materials.

- › **By implementing IBM Maximo, and leveraging its predictive maintenance and monitoring capabilities, this manufacturer effectively transitioned to a replace-as-needed model, extending the average useful lifetime of its tooling from 40 to 50 days.** The senior director for manufacturing operations told Forrester: "We were able to extend the useful lifetime of our equipment without compromising product quality. That alone gave us massive returns. But we're now also able to plan and schedule maintenance more reliably."
- › **By honing its predictive maintenance and automation capabilities, a manufacturer of telecommunications equipment reduced costs associated with repairs for customers by 80% while improving customer satisfaction, since higher uptime and seamless repairs enable those customers to better serve the needs of the marketplace.** Equipment is closely monitored in the field, and the interviewed organization now has the tools required to effectively turn the data it generates into insight.
- › **By leveraging AI/ML for quality control, a manufacturer of industrial, high-technology equipment reduced defects, resulting in materials savings on assembly lines producing millions of units per month.**

**Financial model.** The sample manufacturer's investment in IBM and Red Hat yields five-year, risk-adjusted business acceleration benefits of \$233 million in present value (PV). The sample manufacturer:

- › **Extends average useful lifetime for tooling from 42 to 52 days, owing to predictive monitoring and maintenance capabilities of IBM Maximo.** On average, tooling replacements cost approximately \$2,750, including parts and labor. This benefit applies to approximately 20,000 machines, saving the sample manufacturer upwards of \$55 million per year.
- › **Reduces defects on assembly lines that produce 50 million units of consumer products each year, resulting in material cost savings of up to \$8.6 million per year.** Prior to modernizing factory

"Defect rates are an extremely critical metric for us. What our analytics capabilities, which are built on the IBM Cloud Pak foundation, enable us to do is understand how likely our products are to fail. We test them extensively, but the most reliable data comes from monitoring them in the field. We now have the ability to predict defect rates with a high degree of accuracy."

*Global VP for cloud and AI, electronics and wireless equipment manufacturer*



### The sample manufacturer:

- Extends useful lifetime for tooling on manufacturing lines by 23% through predictive maintenance and monitoring.
- Reduces production defects by 97% by applying AI/ML at the edge for quality monitoring.
- Reduces inventory by 8%, creating savings of 20% for inventory carrying costs.

operations with IBM and Red Hat solutions, the sample manufacturer would see defect rates of approximately 0.7%. After implementing AI/ML and APM, it sees reductions of up to 97% in defect rates.

- › **Reduces inventory by approximately 8%, owing to inventory optimization and forecasting.** As a result, the sample manufacturer reduces carrying costs for that inventory by approximately 20%, amounting to annual savings of \$4.6 million.

“We are rapidly trying to remove data silos and standardize across the organization, which will accelerate our efforts toward that Industry 4.0, more digital model. Red Hat’s technology, which is based on open standards, will play a fundamental role in this transformation.”

*SVP and CIO, industrial, high technology equipment manufacturer*



### Business Acceleration: Calculation Table

EXTENSION OF TOOLING USEFUL LIFETIME	COST OF TOOLING	REDUCTION IN DEFECTS	PRODUCTION UNITS	COST OF GOODS SOLD	RISK ADJUSTMENT
42 to 52 days, on average across 20,000 machines	\$2,750 for materials and labor for each replacement	Up to 97% over five years on a baseline of 0.7%	Up to 50 million units annually at approximately \$30 per unit wholesale cost	90%	High (15%)

## Business Continuity

**Benefit summary.** Investments in IBM and Red Hat solutions enabled the interviewed manufacturing customers to improve the reliability of their operations. The interviewed organizations benefited from greater uptime of IT environments and manufacturing operations, owing to more reliable technology infrastructure and predictive monitoring and maintenance. Environments were also more secure, reducing the risk of costly data breaches and fines. Implementing modern technologies made it easier for interviewed organizations to find, attract, and retain talent, which is significant considering how essential skilled employees are to business continuity.

**Impact to manufacturers.** To deliver goods and services on time, manufacturers need to coordinate among complex networks of suppliers and partners, and they need to ensure that workers and factory operations ramp up production when orders and supplies arrive. Interviewed organizations described how investments in modern technologies from IBM and Red Hat improved the dependability of technology infrastructure and reduced the likelihood of costly periods of downtime. What's more is that they described how modern technologies made it easier to recruit and retain a skilled workforce.

### *Dependability*

- › **An automotive manufacturer reduced IT and manufacturing downtime by replacing legacy systems, including systems managed by external contractors, with modern platforms and software from IBM and Red Hat.** According to the director of digital transformation, there was always a risk of downtime, since systems were cobbled together over more than 30 years, spanning regions and divisions within the interviewed organization. By implementing a platform approach, it eliminated downtime, while improving quality and agility.
- › **A high-technology, industrial equipment manufacturer reduced manufacturing downtime by leveraging predictive maintenance and monitoring capabilities from IBM and Red Hat.** The CIO explained: "By implementing AI and machine learning at the edge, we bring data closer to processes. We can proactively discover potential issues on our assembly lines, which helps us to reduce downtime and keep manufacturing plants operating."
- › **A global consumer electronics and telecommunications equipment manufacturer reduced IT downtime by 95%.** The executive lead for cloud and AI told Forrester that the stability the IBM and Red Hat platform affords enabled the interviewed organization to eliminate periodic downtime that affected productivity for IT and manufacturing operations.

### *Employee Experience*

- › **A global manufacturer of consumer electronics and communications equipment eliminated redundant data processing work, enabling its data science and operations team to focus on business goals.** By eliminating manual, repetitive work, employees' time was freed up for more high-value activities, which in turn keeps them interested in and engaged with their work.
- › **Like other organizations, manufacturing firms struggled to find and recruit talent to maintain legacy systems.** Organizations

"We have hundreds of applications running on the IBM and Red Hat platform, and the benefits we've seen extend beyond our manufacturing environment. We have less downtime, better responsiveness in support, and better utilization of our data. Interestingly, the benefits are still growing, since we're continuing to invest in the hybrid cloud model and all of the technologies that it enables."

*Digital transformation director,  
auto manufacturer*



"With containerized deployments, there's inherent business continuity. If one VM goes down for any reason, there's a seamless handoff to another within the cluster. Therefore, we don't have to put a lot of unnecessary redundancy in place. We can minimize our infrastructure footprint, while maintaining resilience and business continuity."

*Senior operations director, global  
electronics manufacturer*



struggled to find specialists to maintain niche, outdated technologies. Often, employees who built legacy systems left companies, leaving technical debt and a dearth of documentation. A modern, platform-based approach made it easier to recruit and retain employees.

- › **An automotive manufacturer replaced a disparate set of legacy systems, which hindered employee efficiency and productivity.** According to the digital transformation director, employees devoted significant time and effort to keeping systems functioning, which limited the time they could dedicate to advancing the businesses' strategic goals.

**Financial model.** The sample manufacturer's investment in IBM and Red Hat yields five-year, risk-adjusted business continuity benefits of \$20 million in PV. The sample manufacturer:

- › **Reduces costs associated with unplanned downtime for IT and manufacturing operations environments by 95%.** The sample manufacturer realizes direct cost savings for avoided downtime of approximately \$5.6 million per year. Additionally, it realizes up to \$1.6 million of cost savings for remediation of environments in Year 1. By Year 5, cost savings for remediation of environments grow to \$5.3 million, scaling with the share of the IT estate that runs on the IBM and Red Hat hybrid multicloud platform.
- › **Reduces the likelihood of compliance-related fines and expenses.** For the sample manufacturer, Forrester conservatively estimates that IBM and Red Hat solutions contribute to \$300,000 in avoided compliance-related fines and expenses.
- › **Reduces the likelihood of a breach that will impact sales by 80%, owing to built-in security and compliance for application workloads.**
- › **Increases technical employee retention by 80 basis points, from 78% to 78.8%, owing to the adoption of modern technologies from IBM and Red Hat.**
- › **Reduces hiring costs by adopting modern technologies, which make it easier to identify and recruit skilled employees.**



### The sample manufacturer:

- Avoids costs of downtime totaling \$7.2 million per year.
- Reduces the likelihood that a data breach will disrupt business operations by 80%.

**Business Continuity: Calculation Table**

REDUCED HIRING COST FOR IT/OPERATIONS	RETENTION RATE INCREASE	BASELINE RETENTION RATE	BASELINE COST TO HIRE IT/OPERATIONS	BASELINE COST TO HIRE DEVELOPERS	RISK ADJUSTMENT
Up to 6% by Year 5 of the analysis period	1%	78%	\$60,000	\$67,500	Very high (20%)

## Application Development And Maintenance Productivity

**Benefit summary.** By modernizing applications and delivery workflows, interviewed organizations reduced costs to maintain existing applications and realized faster time-to-value for new applications. Development teams benefited from robust microservices frameworks, improved dependency management, and prebuilt automations and integrations. OpenShift enabled them to manage workloads across distributed and hybrid cloud environments.

**Impact to manufacturers.** Customers reported significant improvements in: the speed to develop and maintain new and legacy applications; the ability to scale rapidly with demand; and the ease to deploy applications at the edge. They articulated how cohesive platforms built on RHEL, Red Hat OpenShift, and IBM Cloud Paks contributed to these outcomes. They also described the benefits of professional services such as the Red Hat Container Adoption program to ensure DevOps teams used containers and microservices to their full potential.

- › **A global automotive manufacturer reported a 20% improvement in throughput for application development teams.** The set of capabilities enabled by IBM and Red Hat enabled the automotive manufacturer to develop more agile workflows. The director of digital transformation told Forrester: “Working alongside the technology, we’ve implemented agile workflows, including continuous testing, which have reduced defects and drastically increased throughput. We see much greater output with the same level of effort.” However, the director added that their organization is also better positioned to meet the demands of customers for autonomous, connected vehicles.
- › **A global manufacturer of industrial equipment standardized on RHEL and OpenStack. This enabled rapid updates for their company’s manufacturing execution system (MES) across its 140 manufacturing sites.** Prior to engaging with IBM and Red Hat, the interviewed organization frequently dedicated teams as large as 40 people over the course of three weeks to roll out updates to the MES at a single site. By containerizing workloads, it reduced deployment times from weeks to days. Deployments also required fewer technical resources, allowing the organization to focus on innovations identified as part of its “Factory of the Future” initiative.
- › **A global manufacturer of consumer electronics and telecommunications equipment explained how professional services teams from IBM and Red Hat assist their organization’s efforts to modernize and innovate.** The global vice president for cloud and AI explained: “We invest almost as much in professional services as the technology. We work alongside a set of experts from IBM, who are helping us to revamp our integrated product development systems.”

“Our ‘Factory of the Future’ initiative is among our highest strategic priorities for the next 24 months. Red Hat, Maximo, and the Cloud Pak for Integration will be critical for us, since we need to connect everything across the enterprise.”

*Senior operations director, global electronics manufacturer*



“We are rapidly trying to remove data silos and standardize across the organization, which will accelerate our efforts toward that Industry 4.0, more digital model. Red Hat’s technology, which is based on open standards, will play a fundamental role in this transformation.”

*SVP and CIO, industrial, high technology equipment manufacturer*



**Financial model.** The sample manufacturer's investment in IBM and Red Hat yields five-year, risk-adjusted application development and maintenance productivity benefits of \$42 million in PV. The sample manufacturer:

- › **Speeds up application development time by 43%, shortening release cycles that previously took 28 weeks by an average of 12 weeks.** By automating infrastructure deployments, streamlining service integrations, and implementing continuous testing and integration, the sample manufacturer slashes costs for application development by approximately \$250,000 per application.
- › **Builds 60 new applications over the five-year period of analysis.** In Year 1, the sample manufacturer builds five new applications; in Year 2, it builds 15 new applications; and in Years 3 and 4, it builds 20 new applications in each year.
- › **Decreases annual maintenance for modern applications by 44%.** Modern applications require less effort to maintain, owing to the inherent simplicity of a microservices architecture.
- › **Modernizes approximately 300 applications over the five-year period analysis.** In Year 1, the sample manufacturer modernizes eight legacy applications, making it easier to maintain and update these apps. In Year 5, the sample manufacturer modernizes 114 applications.
- › **Decreases annual maintenance for containerized legacy applications by 22%.** Prior to modernizing legacy applications, development teams dedicated roughly eight weeks to maintenance and updates for each app, each year. By containerizing applications, development teams avoid two weeks of effort, saving maintenance and updates costs of approximately \$83,000 per application, per year.



### The sample manufacturer:

- Speeds up application development time by 43%.
- Decreases annual maintenance for modern applications by 44%.
- Decreases maintenance for containerized legacy applications by 22%.

#### Application Development And Maintenance Productivity: Calculation Table

IMPROVED PRODUCTIVITY IN NEW APP DEVELOPMENT	NUMBER OF NEW APPS DEVELOPED	IMPROVED PRODUCTIVITY FOR MAINTENANCE FOR APPS IN IBM AND RED HAT PLATFORM	IMPROVED PRODUCTIVITY FOR MAINTENANCE FOR MODERN APPS	NUMBER OF APPS IN IBM AND RED HAT PLATFORM	RISK ADJUSTMENT
43% increase in development speed	5 in Year 1; 15 in Year 2; 20 each in Years 3 and 4	22% improvement	44% improvement	198 by Year 5 of the analysis; 114 of these apps are modernized apps while the remaining 84 are legacy apps managed in the IBM/Red Hat platform	High (15%)



## Infrastructure Cost Efficiency For Labor

**Benefit summary.** Interviewed organizations realized significant labor cost savings, owing to efficiencies in managing and provisioning technology infrastructure supported by IBM and Red Hat solutions. The RedHat OpenShift Container Platform simplified administration and maintenance of migrated and cloud-native applications, since complexity is abstracted away, and administrators aren't focused on multiple deployment configurations. Cloud Paks for Data and Integration reduce manual, repetitive work for business analysts and data scientists who struggled to rationalize data from across disparate sources before analysis and insights development began.

**Impact to manufacturers.** Customers attributed significant cost savings to the automation of repetitive, manual work required to support business critical infrastructure. Following modernization efforts, they reallocated and retrained IT administrators and support specialists to other roles within their organizations. Business analysts and data scientists who previously spent a significant share of working hours cleaning and aggregating data gained time to focus on higher-value tasks like analysis and insights development.

- › **An industrial equipment manufacturer reduced costs of effort to deploy and manage infrastructure across the application development lifecycle by 30% to 40%.** The interviewed organization used Red Hat Ansible to automate provisioning, configuration management, and application deployment, reducing the cost of effort across an IT operations team composed of more than 500 administrators and analysts. According to the executive lead for IoT, AI, and analytics, the efficiencies are even greater within the R&D organization, where projects are shorter and more frequent.
- › **A manufacturer of consumer electronics and telecommunications equipment eliminated manual, repetitive work for data scientists and business analysts, owing to its adoption of the IBM Cloud Paks for Data and Integration.** Prior to engaging IBM and Red Hat, the interviewed organization invested heavily in a cloud data platform from an alternative provider. However, data was still stored in silos and required significant cleaning and transformation before any analysis could begin. According to a global VP of cloud and AI, several of their organization's highly qualified data scientists and business analysts spent up to 80% of their time cleaning data, which increased costs and impacted employees' view of their work.

"Prior to deploying the IBM Cloud Pak for Data, we lacked higher level integration and connectivity across processes, even though the data was there. There were manual processes involved in moving data from one place to another, and it hindered collaboration across the enterprise. Now, with that higher level integration, and the collaboration it enables, we can move faster."

*SVP and CIO, industrial, high technology equipment manufacturer*



"Our 'Factory of the Future' initiative is among our highest strategic priorities for the next 24 months. Red Hat, Maximo, and the Cloud Pak for Integration will be critical for us, since we need to connect everything across the enterprise."

*Senior director of operations, electronics manufacturer*



**Financial model.** The sample manufacturer's investment in IBM and Red Hat yields a five-year, risk-adjusted infrastructure cost efficiency for labor benefits of \$87 million in PV. The sample manufacturer:

- › **Reallocates up to 30% of infrastructure admins for data center hardware by deploying the IBM and Red Hat platform.** The sample manufacturer begins with 165 admins dedicated to managing data center hardware. By Year 5 of the analysis period, it reallocates 50 infrastructure admins to higher-value tasks.
- › **Reallocates all infrastructure admins for application environments that are migrated to the cloud.** At the start of the analysis period, the sample manufacturer employs 150 infrastructure admins to manage environments for applications that will be migrated to the cloud. Each year, as application migrations are completed, the sample manufacturer reallocates 20% of the admin staff to higher-value tasks.
- › **Reallocates 70% of middleware admins by using prepackaged services from IBM and Red Hat catalogs.** At the start of the analysis period, the sample manufacturer employs 135 middleware admins. In Year 1, it reallocates seven middleware admins to higher-value tasks. And by Year 5, it reallocates 95 of its middleware admins to higher-value tasks.
- › **Improves productivity for platform and operations administrators by up to 40%.** By taking advantage of monitoring, management, and automation capabilities of the IBM and Red Hat hybrid cloud platform, the sample manufacturer increases productivity for platform and operations administrators by 5% in Year 1 of the analysis. By Year 5, it improves baseline productivity for platform and operations administrators by 40%.
- › **Improves productivity for data scientists and business analysts by 30%.** By consolidating and rationalizing data stores with the IBM Cloud Paks for Data and Integration, the sample manufacturer reduces the time business analysts and data scientists spend on aggregation and cleaning of data prior to analysis. To produce a conservative estimate of the impact of this investment on productivity, Forrester assumes that only 50% of the time savings are directly reinvested in productive activities.



## The sample manufacturer:

- Reallocates up to 30% of infrastructure admins for data center hardware.
- Reallocates all infrastructure admins for application environments migrated to the cloud.
- Reallocates 70% of middleware admins by using prepackaged services from IBM and Red Hat.
- Improves productivity for platform and operations admins by 40%.
- Improves productivity for data scientists and business analysts by 30%.

**Infrastructure Cost Efficiency For Labor: Calculation Table**

INFRASTRUCTURE ADMINS FOR CORE HARDWARE	INFRASTRUCTURE ADMINS FOR MIGRATABLE HARDWARE	MIDDLEWARE ADMINS	PLATFORM AND OPERATIONS ADMINS	AVERAGE FULLY BURDENED ANNUAL SALARY FOR IT ADMINS	RISK ADJUSTMENT
165 Initial admins with 30% reallocated by Year 5 of the analysis period	150 Initial admins with 100% reallocated by Year 5 of the analysis period	135 Initial admins with 70% reallocated by Year 5 of the analysis period	300 Initial admins with 20% relocated by Year 5 of the analysis period	\$120,000	Moderate (10%)

## Infrastructure Cost Efficiency For Technology

**Benefit summary.** Interviewed organizations invested in hybrid multicloud platforms from IBM and Red Hat. These investments enabled them to avoid hardware and operational costs; control cloud spending; and reduce software licenses required to support application workloads. Cash flows improved, since usage-based fees supplanted capital-intensive upfront purchases of hardware and software licenses. As an added benefit, interviewed organizations eliminated the possibility of lock-in to any one vendor or technology environment, enabling them to take advantage of opportunities to optimize workloads for cost.

**Impact to manufacturers.** Customers reported cost savings from: 1) migrating legacy applications to the cloud and replacing legacy hardware; 2) optimizing hardware resources with platform management; 3) optimizing cloud resource consumption; 4) avoiding overprovisioning through cloud scalability; and 5) avoided software licenses.

› **A manufacturer of consumer electronics and telecommunications equipment realized significant savings from implementing the IBM Cloud Pak for Data.** According to the global vice president for cloud and AI, the interviewed organization has saved \$6 for every dollar that it has spent on the IBM Cloud Pak for Data. The savings include avoided licensing, maintenance, and data egress costs, which totaled more than \$1 million per year for the organization's preexisting data warehouse platform. However, lower platform costs are only part of the equation. The interviewed organization saves on training and labor costs, since the platform enables analysts to easily blend data and develop models. And the business derives actionable insights from its data much faster than it did in the past.

› **A global electronics manufacturer reported significant cost savings for software licensing by standardizing on RHEL.** Additionally, RHEL also enables the interviewed organization to efficiently deploy applications at the edge. The senior operations director told Forrester: "RHEL powers our entire manufacturing footprint, and the reason it's so impressive is that it's an open standard. All of our deployments today are containerized, and we can deploy containers at the edge. Moving data from the edge, to one of our cloud platforms is seamless."

› **An industrial equipment manufacturer increased average hardware utilization from approximately 35% to upwards of 60% with a hybrid cloud platform from IBM and Red Hat.** The ability to quickly shift workloads to the public cloud to take advantage of bursting capabilities is a key driver of hardware cost savings. The executive lead for IoT, AI, and analytics explained: "Our IT organization previously kept a large buffer for cycle demand; now we're able to quickly shift workloads to scale up quickly."

**Financial model.** The sample manufacturer's investment in IBM and Red Hat yields a five-year, risk-adjusted infrastructure cost efficiency for technology benefits of \$396 million in PV. The sample manufacturer:

› **Decommissions 85 server racks over five years by moving business critical applications to the cloud.** By moving apps to the cloud and decommissioning server racks in its data center, the sample manufacturer avoids one-time fees at standard refresh cycles for maintenance of hardware, storage, and networking equipment. It is also able to avoid operational costs such as power, cooling, and facilities costs.

"We are using IBM and Red Hat as a holistic platform for open manufacturing — diagnosing problems, optimizing and scaling production, and eliminating data silos."

*CIO, industrial, high technology equipment manufacturer*



"We use the Red Hat and IBM portfolio of solutions in a hybrid cloud environment to understand data and cocreate solutions with our customers."

*Executive lead for IoT, AI, and analytics*





## The sample manufacturer:

- › **Optimizes remaining legacy hardware management through platform management.** By deploying Red Hat Enterprise Linux (RHEL), Red Hat OpenShift, and IBM Cloud Paks, the sample manufacturer reduces resource requirements for remaining legacy hardware by 20%, on average. Better utilization translates to fewer servers in the legacy environment, which in turn reduces one-time and ongoing costs for hardware, storage, and networking equipment.
- › **Optimizes cloud resource consumption with platform management.** By running applications in a container-based platform, the sample manufacturer reduces average resource requirements for workloads running in IBM and third-party clouds by 20%, on average. In Year 1 of the analysis period, the sample manufacturer migrates 74 apps to IBM and third-party cloud platforms, enabling it to decommission 17 server racks. By Year 5, it migrates a total of 210 apps to IBM and third-party cloud platforms for a total of 85 server racks.
- › **Optimizes cloud resources with app modernization.** By applying a microservices architecture to applications, and using prepackaged cloud services, the sample manufacturer reduces average resource requirements for application workloads hosted in the cloud by 30%, on average. In Year 1 of the analysis period, the sample manufacturer modernizes eight of its cloud-hosted applications. By Year 5, it modernizes 114 of its cloud-hosted applications.
- › **Reduces software licensing costs through better utilization.** The sample manufacturer reduces software license fees by 15%, on average, to support application workloads that run in the IBM and Red Hat platform. For modernized applications, it reduces software licensing costs by an additional 35%.
- › **Avoids overprovisioning with containers and cloud scalability.** By running applications in the cloud, the sample manufacturer can scale resources quickly and avoid 15% of excess costs associated with overprovisioning for peak demand.
- › **Avoids costs associated with infrastructure lock-in.** Over the five-year period of analysis, the sample manufacturer places workloads in the on-premises and cloud environment that made the most economic sense, avoiding up to \$10.1 million in costs. Workload portability is a key enabler of this benefit.

- Reduces resource requirements for apps running on legacy hardware by 20%.
- Reduces resource requirements for apps running in OpenShift by 20%.
- Reduces resource requirements for modern apps by 30%.
- Reduces software licensing costs through better utilization by 35%.
- Reduces hardware and operations costs associated with overprovisioning by 15%.

### Infrastructure Cost Efficiency For Technology: Calculation Table

HARDWARE AND OPERATIONAL COST SAVINGS OF DECOMMISSIONING LEGACY SERVERS	BENEFITS OF PLATFORM MANAGEMENT FOR LEGACY HARDWARE	BENEFITS OF PLATFORM MANAGEMENT FOR CLOUD RESOURCES	OPTIMIZE CLOUD RESOURCES WITH APP MODERIZATION	AVOID OVERPROVISIONING WITH CLOUD SCALABILITY	RISK ADJUSTMENT
Up to \$61 million by Year 5 of the analysis	Up to \$7.1 million by Year 5 of the analysis	Up to \$33.1 million by Year 5 of the analysis	Up to \$27 million by Year 5 of the analysis	Up to \$25 million by Year 5 of the analysis	Moderate (10%)

## Unquantified Benefits

Interviewed organizations also described the following benefits that were unique to their business that they could not yet quantify:

- › **Improved productivity for frontline workers.** Interviewed organizations realized greater productivity from frontline workers, owing to technology investments with IBM and Red Hat. When technology issues cause downtime for manufacturing lines, workers sit idle until those issues are resolved, driving up costs of production. By eliminating downtime, frontline workers' time is better utilized. Similarly, effective supply chain management, enabled by a robust data infrastructure, ensures that parts and materials are available when they're needed, and that stock issues don't cause production bottlenecks.
- › **Enhanced business agility.** Prior investments in modernization enabled interviewed organizations to quickly adapt to the COVID-19 pandemic. When business conditions required an automotive manufacturer to eliminate some positions in its IT division, it was able to do so without impacting throughput or quality. The digital transformation director told Forrester, "We were more agile, and our systems were more scalable, so we were able to weather the pandemic very effectively."
- › **Improved supply chain health.** By investing in modern data architectures and integration capabilities, the interviewed organizations gained insight into customer demand and the health of their supply chains. Large manufacturers source inputs from all over the world. The ability to accurately forecast demand, and to collaborate with suppliers in real time, relies on enterprisewide integration of data from procurement to marketing to operations. The CIO for an industrial, high technology equipment manufacturer explained how demand forecasting and real-time collaboration with suppliers impacts customer satisfaction: "We have suppliers who depend on our forecasts, and if we don't provide them with accurate forecasts of where you need materials at sites around the world, we won't have the raw inputs we need to build products for our customers. We could jeopardize our entire value chain."
- › **Improved customer understanding.** By rationalizing disparate databases, an automotive manufacturer gained a better understanding of its customers, enabling their delivery of personalized offers and experiences. Prior to investing in IBM Cloud Paks for Data and Integration, customer data was stored in silos, with individual databases for sales, marketing, financing, and services. After building a single view of its customers, the interviewed organization began delivering targeted communications, which boosted revenues for services and upgrades in select markets by as much as 20%.

"Part of our business is as a contract manufacturer, so we need to adapt to our customers' environments. When we're doing work for a company that has specific cloud requirements, OpenShift lets us deploy to that cloud environment."

*Senior director of operations,  
global electronics manufacturer*



"We have suppliers who depend on our forecasts, and if we don't provide them with accurate forecasts of where you need materials at sites around the world, we won't have the raw inputs we need to build products for our customers — we could jeopardize our entire value chain."

*SVP and CIO, industrial, high  
technology equipment  
manufacturer*





## Flexibility

There are many scenarios in which manufacturers might implement solutions from IBM and Red Hat and later realize additional uses and business opportunities, including the following:

- › **Integrating new technologies.** Investments in modern technologies and methodologies improved development teams' ability to integrate new technologies. The digital transformation director for an automotive manufacturer explained: "When we started working with agile teams, it required a massive adjustment across our 150 teams. However, after a while, we noticed that when we integrated new technologies, we'd start seeing results much more quickly. We were getting more throughput, without any increase in effort. The investment is paying dividends for us."
- › **Meeting the rapidly evolving needs of the marketplace.** Agile workflows, enabled by investments in modern technologies, allow interviewed organizations to better meet the demands of customers, even though they change rapidly. For example, the digital transformation director for an automotive manufacturer explained that agile teams are better equipped to compete in a marketplace where cars are increasingly connected and autonomous. Better understanding of customers through data, enabled by investments in the IBM Cloud Pak for Data, also enabled organizations to adapt and build products to customers' requirements.
- › **Cocreating solutions with customers.** Shared technology environments foster collaboration between manufacturers and their customers. According to the executive lead for IoT, AI, and analytics at an industrial equipment manufacturer, flexibility and portability are essential to making cocreation work: "Our customer base is diversified across industries and geographies, so technology collaborations require flexible, secure, easy-to-integrate solutions. Portability is also a big factor — solutions should be easy to port from one cloud environment to another to meet customer expectations."
- › **Scaling proofs of concept.** The ability to effectively combine smart manufacturing technologies is increasingly important to manufacturers' ability to win, serve, and retain customers. To that end, interviewed organizations routinely build proofs of concept to test new applications of digital twins, AI and ML, augmented reality, and edge computing, among other technologies. The CIO for an industrial, high-technology equipment manufacturer told Forrester: "We're thinking about the enterprise as an open ecosystem, optimizing processes with cloud computing, AI and machine learning, big data, and edge applications. This state-of-the-art technology allows us to take pilot programs and proofs of concept to enterprisewide scale."
- › **Building digital engagement strategies.** For manufacturers, digital engagement strategies are becoming increasingly important.<sup>4</sup> In some cases, manufacturers face competition from direct-to-consumer brands. In others, buyers are increasingly hesitant to engage with salespeople, relying instead on self-directed research. Data architectures that enable manufacturers to develop customer insights and future-proof their sales strategies are critical to ongoing success.

"In a hyper-connected manufacturing enterprise, applications talk to applications; people talk to applications; and machines talk to applications. A microservices architecture makes this all work. But you also need an effective ESB [enterprise service bus], which we get from the IBM Cloud Pak for Integration."

*Senior director of operations,  
global electronics manufacturer*



"Our customer base is diversified across industries and geographies, so technology collaborations require flexible, secure, easy-to-integrate solutions. Portability is also a big factor — solutions should be easy to port from one cloud environment to another to meet customer expectations."

*Executive lead for IoT, AI, and  
analytics, industrial equipment  
manufacturer*





# Analysis Of Costs

## QUANTIFIED COST DATA AS APPLIED TO THE COMPOSITE

Total Costs							
COST	INITIAL	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	PRESENT VALUE
Technology	\$21,000,000	\$63,244,069	\$78,505,779	\$106,578,248	\$131,277,392	\$154,460,438	\$409,021,238
Professional services for transformation	\$21,000,000	\$21,000,000	\$15,750,000	\$5,250,000	\$0	\$0	\$57,051,841
Professional services for management and support	\$0	\$6,028,000	\$6,028,000	\$6,028,000	\$6,028,000	\$6,028,000	\$22,850,863
Training	\$31,680,000	\$7,774,536	\$7,501,472	\$7,297,312	\$7,090,600	\$7,014,040	\$59,628,044
<b>Total costs (risk-adjusted)</b>	<b>\$73,680,000</b>	<b>\$98,046,605</b>	<b>\$107,785,251</b>	<b>\$125,153,560</b>	<b>\$144,395,992</b>	<b>\$167,502,478</b>	<b>\$548,551,986</b>

## Technology

Modernization, cloud migration, and container platform implementation require significant investments in hardware, software, and cloud capacity.

The following technology cost assumptions inform the financial model:

- › **On-premises apps, as well as those that are migrated to the cloud, are hosted in the IBM Cloud.** The sample manufacturer incurs usage-based cloud costs for these applications.
- › **The sample manufacturer incurs subscription costs for RHEL, Red Hat OpenShift, and IBM Cloud Paks for Applications, Data, Multicloud Management, and Integration.** It may incur additional costs for services such as Red Hat Virtualization, Gluster Storage, Ansible, IBM WebSphere Liberty, Db2, or MQ.
- › **The sample manufacturer incurs subscription-based costs for IBM Maximo** for APM and inventory optimization.
- › **Cash flows for the sample manufacturer with the switch to monthly subscriptions and usage-based fees versus from the upfront license purchase model.**

### Technology: Calculation Table

ADDITIONAL HARDWARE FOR AI AND IOT	APM ONGOING COSTS	NUMBER OF CLOUD APPS	CLOUD/PLATFORM COST PER APP	RISK ADJUSTMENT
\$30 million	\$2.4 million	59 increasing to 164 (adjusted to reflect resource savings from benefit section)	\$800K	Low (5%)

# Professional Services

Manufacturers relied on professional services from IBM to implement and scale modern technologies, avoiding missteps and realizing faster time-to-value. While services represent a significant investment, the interviewed organizations found them to be essential.

The interviewed organizations leveraged the following professional services from IBM and Red Hat:

- › **The Red Hat Container Adoption Program, Red Hat Open Innovation Labs, and IBM Garage** to accelerate modernization and product innovation efforts.
- › **IBM Services** for strategy, design, implementation, and deployment of hardware, cloud technology, and the container platform.
- › **IBM and Red Hat services** for ongoing support and expertise.

The following assumptions inform the financial model:

- › A total investment of approximately \$60 million for transformation and modernization services, particularly for the Red Hat Container Adoption Program, over the five-year period of analysis.
- › A total budget of approximately \$6 million per year for ongoing management and support.

Readers should note that internal labor from IT administrators, developers, and cross-functional leadership was also crucial throughout the process. However, this work resulted in a net reduction rather than in a net increase in internal FTEs for the IT and operations teams, even with the significant time dedicated to this effort. As this model shows a reduction in FTEs, with their employment costs already incurred by default, the value of their internal labor is not added as a line item to this ROI analysis to avoid double-counting.

## Professional Services: Calculation Table

PLANNING, DEPLOYMENT, IMPLEMENTATION	ANNUAL MANAGEMENT AND SUPPORT	RISK ADJUSTMENT
\$60 million over three years	\$6 million per year	Low (5%)

## Training

Manufactures invested in training for developers, administrators, operations experts, and data scientists, among other roles, to ensure employees were well-equipped to leverage modern technologies from IBM and Red Hat. The sample manufacturer:

- › **Delivers initial and ongoing training to IT and operations admins.** The sample manufacturer initially provides 160 hours of training to each of its 750 IT and operations admins. Each year, admins receive 40 hours of additional training. By Year 5 of the analysis, the number of IT and operations admins requiring training declines to 395, since environments based on the IBM and Red Hat hybrid cloud platform are easier to provision and maintain.
- › **Delivers initial and ongoing training to developers.** The sample manufacturer initially provides 160 hours of training to each of its 2,100 developers. Each year, developers receive 40 hours of additional training.

To produce a conservative estimate of training required to realize the benefits outlined in this study, Forrester applied a 10% risk adjustment to account for unknowns in preexisting skillsets of employees, familiarity with modern architectures, and experience with specific technologies.

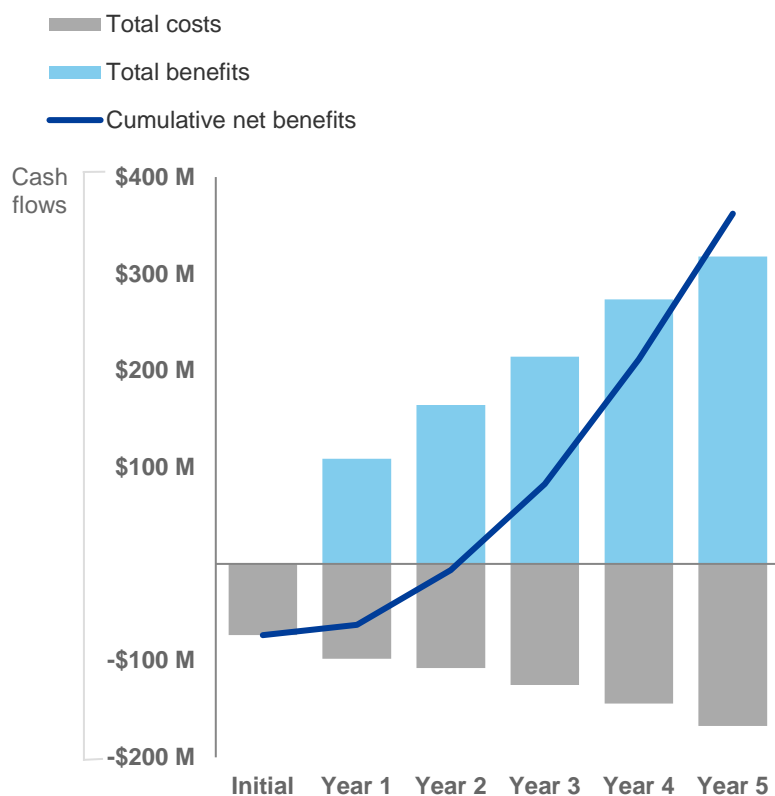
### Training: Calculation Table

IT/OPS FTEs	IT/OPS SALARY	DEVELOPER FTEs	DEVELOPER SALARY	INITIAL TRAINING	CONTINUING TRAINING	RISK ADJUSTMENT
750	\$58 per hour	2,100	\$65 per hour	160 hours	40 hours per year	Moderate (10%)

# Financial Summary

## CONSOLIDATED FIVE-YEAR RISK-ADJUSTED METRICS

### Cash Flow Chart (Risk-Adjusted)



The financial results calculated in the Benefits and Costs sections can be used to determine the ROI, NPV, and payback period for the composite organization's investment. Forrester assumes a yearly discount rate of 10% for this analysis.



These risk-adjusted ROI, NPV, and payback period values are determined by applying risk-adjustment factors to the unadjusted results in each Benefit and Cost section.

### Cash Flow Table (Risk-Adjusted)

	INITIAL	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	PRESENT VALUE
Total costs	(\$73,680,000)	(\$98,046,605)	(\$107,785,251)	(\$125,153,560)	(\$144,395,992)	(\$167,502,478)	(\$548,551,986)
Total benefits	\$0	\$108,672,858	\$164,315,569	\$214,283,194	\$273,440,240	\$317,999,401	\$779,801,604
Net benefits	(\$73,680,000)	\$10,626,252	\$56,530,317	\$89,129,634	\$129,044,247	\$150,496,923	\$231,249,618
ROI							42%
Payback period							25 months

# Appendix A: Total Economic Impact

Total Economic Impact is a methodology developed by Forrester Research that enhances a company's technology decision-making processes and assists vendors in communicating the value proposition of their products and services to clients. The TEI methodology helps companies demonstrate, justify, and realize the tangible value of IT initiatives to both senior management and other key business stakeholders.

## Total Economic Impact Approach



**Benefits** represent the value delivered to the business by the product. The TEI methodology places equal weight on the measure of benefits and the measure of costs, allowing for a full examination of the effect of the technology on the entire organization.



**Costs** consider all expenses necessary to deliver the proposed value, or benefits, of the product. The cost category within TEI captures incremental costs over the existing environment for ongoing costs associated with the solution.



**Flexibility** represents the strategic value that can be obtained for some future additional investment building on top of the initial investment already made. Having the ability to capture that benefit has a PV that can be estimated.



**Risks** measure the uncertainty of benefit and cost estimates given: 1) the likelihood that estimates will meet original projections and 2) the likelihood that estimates will be tracked over time. TEI risk factors are based on "triangular distribution."

The initial investment column contains costs incurred at "time 0" or at the beginning of Year 1 that are not discounted. All other cash flows are discounted using the discount rate at the end of the year. PV calculations are calculated for each total cost and benefit estimate. NPV calculations in the summary tables are the sum of the initial investment and the discounted cash flows in each year. Sums and present value calculations of the Total Benefits, Total Costs, and Cash Flow tables may not exactly add up, as some rounding may occur.



### Present value (PV)

The present or current value of (discounted) cost and benefit estimates given at an interest rate (the discount rate). The PV of costs and benefits feed into the total NPV of cash flows.



### Net present value (NPV)

The present or current value of (discounted) future net cash flows given an interest rate (the discount rate). A positive project NPV normally indicates that the investment should be made, unless other projects have higher NPVs.



### Return on investment (ROI)

A project's expected return in percentage terms. ROI is calculated by dividing net benefits (benefits less costs) by costs.



### Discount rate

The interest rate used in cash flow analysis to take into account the time value of money. Organizations typically use discount rates between 8% and 16%.



### Payback period

The breakeven point for an investment. This is the point in time at which net benefits (benefits minus costs) equal initial investment or cost.

## Appendix B: Supplemental Material

Forrester referenced data from the following research and studies in formulating this analysis:

“Emerging Technology Assessment: The Total Economic Impact™ Of Using Both IBM And Red Hat Solutions Together,” a commissioned study conducted by Forrester Consulting on behalf of IBM, June 2019.

“Emerging Technology Projection: The Total Economic Impact™ Of IBM Blockchain,” a commissioned study conducted by Forrester Consulting on behalf of IBM, July 2018.

“The Real Costs Of Planned And Unplanned Downtime,” a commissioned study conducted by Forrester Consulting on behalf of IBM, August 2019.

“The Total Economic Impact™ Of IBM Cloud For VMware Solutions,” a commissioned study conducted by Forrester Consulting on behalf of IBM, September 2019.

“New Technology: The Projected Total Economic Impact™ Of IBM Cloud Pak For Data,” a commissioned study conducted by Forrester Consulting on behalf of IBM, February 2020.

“The Total Economic Impact™ Of IBM Cloud Private,” a commissioned study conducted by Forrester Consulting on behalf of IBM, March 2019.

“The Total Economic Impact™ Of IBM’s Design Thinking Practice,” a commissioned study conducted by Forrester Consulting on behalf of IBM, February 2018.

“The Total Economic Impact™ Of IBM Multivendor Support Services (MVS),” a commissioned study conducted by Forrester Consulting on behalf of IBM, January 2019.

“The Total Economic Impact™ Of IBM® Power Systems™ For S4HANA®,” a commissioned study conducted by Forrester Consulting on behalf of IBM, July 2019.

“The Total Economic Impact™ Of IBM Services For Application Migration And Modernization To A Hybrid Multicloud Environment,” a commissioned study conducted by Forrester Consulting on behalf of IBM, September 2019.

“The Total Economic Impact™ Of IBM Watson Studio And Watson Knowledge Catalog,” a commissioned study conducted by Forrester Consulting on behalf of IBM, July 2018.

“The Total Economic Impact™ Of IBM WebSphere Liberty,” a commissioned study conducted by Forrester Consulting on behalf of IBM, September 2018.

“The Total Economic Impact™ Of Red Hat Ansible Tower,” a commissioned study conducted by Forrester Consulting on behalf of Red Hat, June 2018.

“The Total Economic Impact™ Of Red Hat Consulting’s Container Adoption Program And Red Hat Open Innovation Labs,” a commissioned study conducted by Forrester Consulting on behalf of Red Hat, June 2018.

“The Total Economic Impact™ Of Red Hat OpenShift Dedicated,” a commissioned study conducted by Forrester Consulting on behalf of Red Hat, June 2019.

“The Total Economic Impact™ Of Red Hat Virtualization,” a commissioned study conducted by Forrester Consulting on behalf of Red Hat, July 2019.

“The Total Economic Impact™ Of IBM® Maximo® MRO Inventory Optimization,” a commissioned study conducted by Forrester Consulting on behalf of IBM, May 2019.

“Unlock Open Source Technology’s Full Value,” a commissioned study conducted by Forrester Consulting on behalf of IBM, October 2019.

“Predictions 2021: Smart Manufacturing,” Forrester Research, Inc., October 28, 2020.

“The Forrester Tech Tide™: Smart Manufacturing, Q2 2020,” Forrester Research, Inc., April 1, 2020.

“IoT Transforms Supply Chain Management,” Forrester Research, Inc., December 11, 2020.

“Benchmark Your Digital Supply Chain For Resilience In The Age Of The Customer,” Forrester Research, June 4, 2020.



# Appendix C: Endnotes

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<sup>1</sup> Source: Paul Miller (Principal Analyst), “How Manufacturing Will Get Smarter In 2021,” What It Means, Forrester Research, Inc., December 17, 2020 (<https://go.forrester.com/what-it-means/ep197-smart-manufacturing/>).

<sup>2</sup> Source: Nigel Fenwick, “Survival-Mode Digital Strategy: Focus On Pragmatic Modernization,” Forrester Research, Inc., August 14, 2020.

<sup>3</sup> Source: “The Forrester Tech Tide™: Smart Manufacturing, Q2 2020,” Forrester Research, Inc., April 1, 2020.

<sup>4</sup> Source: “It’s Time To Wake Up Or Shake Up B2B Marketing In Manufacturing,” Forrester (<https://www.forrester.com/fn/2CEqLaNQJFmyuf3QSgFQq5>).