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The Digitalization Productivity Bonus

What value does digitalization
offer manufacturers?

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Management Summary

- Adoption of digitalization in manufacturing – "Industry 4.0" – is accelerating as pioneers demonstrate the substantial efficiency and competitive advantages that digital transformation offers.
- Manufacturing CFOs, however, require measurable outcomes on which to base their investment in digital transformation.
- Original research involving management consultants, manufacturers and academics indicates consensus across the globe that measurable improvements in manufacturing productivity are the CFOs' starting point, a concept that is relatively straightforward to translate into solid financial gain.
- Respondents to this research paper estimate that potential annual manufacturing productivity gains from digital transformation, the *Digitalization Productivity Bonus*, will total between 6.3% and 9.8% of overall revenue by 2025.
- Industry observers also note that a new mindset is required of manufacturers for them to fully benefit from digitalization – a mindset that introduces digital capabilities and skills into strategic thinking.
- At the same time, new approaches are required from financiers to create a specialized portfolio of financing techniques – "Industry 4.0 Finance" – that enables the affordable and sustainable transition to smart, digitalized factories.
- Industry 4.0 Finance is now employing a new mindset to offer techniques that can:
 - Embed sustainable financing options right from the start of digital transformation
 - Be tailored to each manufacturer's rate of benefit from digitalization
 - Apply cost-saving or increased revenue outcomes to fund enabling technology
 - Offer options to seize new innovations as they appear
 - Bridge the gap between technology adoption and the resulting commercial gains
 - Cover the total solution and total cost of ownership (hardware, software, services)
 - Employ machine data to ensure that finance is based on usage or outcomes, aligning technology capabilities with their resulting commercial benefits

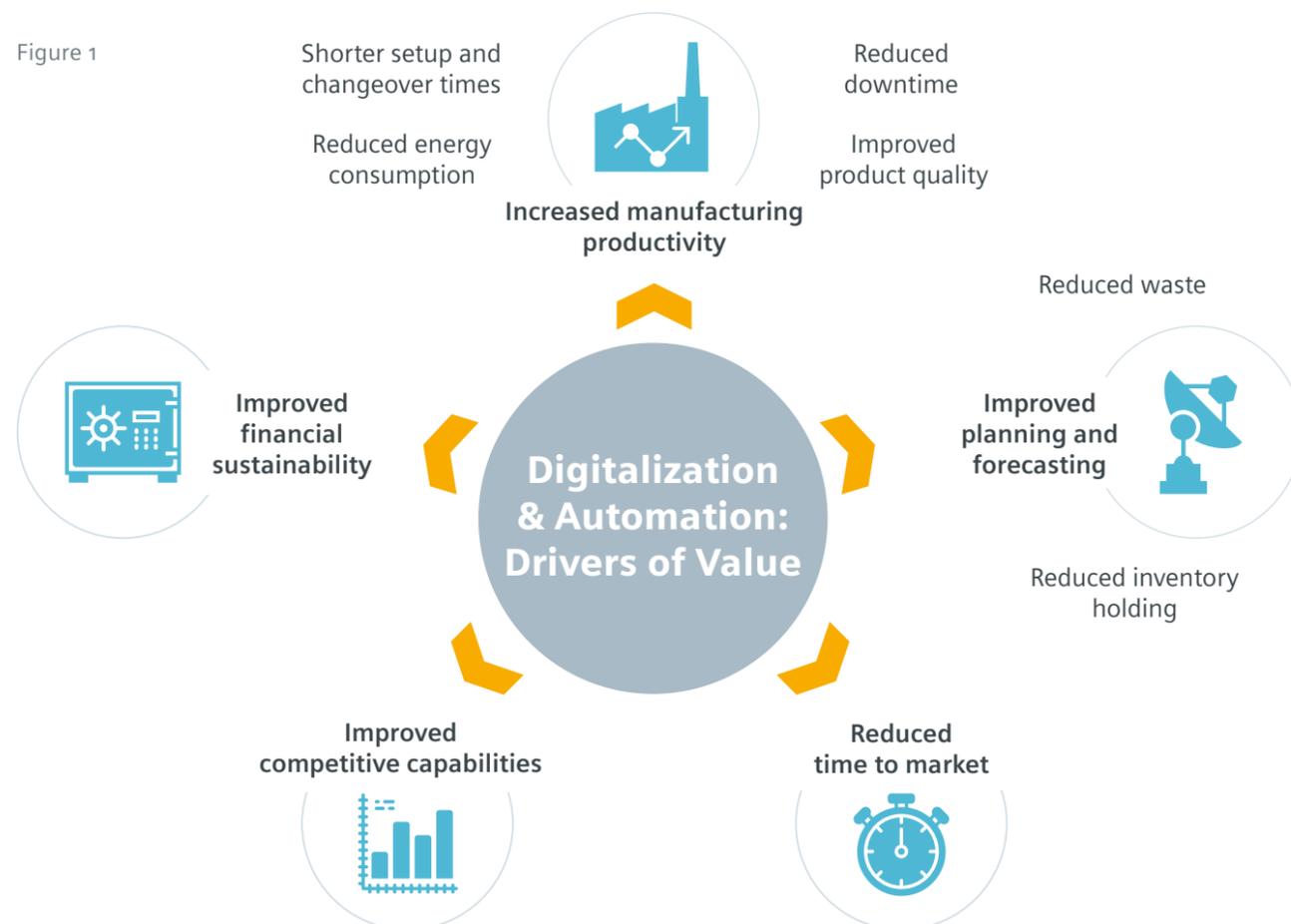
The value of digitalization: Dimensions and perspectives

Industry 4.0, the Fourth Industrial Revolution, is inexorably gathering strength. Industry 4.0 introduces the digitalization of processes, the Internet of Things, the installation of widespread sensors in the physical environment and the ability to rapidly enhance production economics through real-time performance-data analysis. The new generation of digitalized, automated technology now available is enabling manufacturers around the world to improve overall performance and reduce time to market through virtualized product and process development, improved productivity, increased manufacturing plant and equipment uptime through remote monitoring and predictive maintenance as well as improved competitive

capabilities through mass customization, where tailored products are offered with much the same economies formerly associated with mass production.¹

Industry 4.0 represents a significant opportunity for manufacturers to offer their customers enhanced product ranges and quality in tandem with more competitive pricing. Drawing on original research and a variety of published sources, this paper summarizes the key points of value that digitalization and automation have been delivering to those pioneering companies that have already started to invest in the new wave of digitalized technology. These key points of value are summarized in the diagram below (figure 1).

Figure 1



The benefits of digitalization in manufacturing that drive commercial value are worth summarizing briefly and placing in a real-life context.

The vast majority of manufacturers and expert consultants interviewed for this paper² confirm that the ability to **increase manufacturing productivity** is the starting point for deriving measurable value from digitalization. The ability to manufacture the same product volume at less cost, or to manufacture more products for little or no increase in costs, resonates with manufacturers considering investing in digital technology to enable competitiveness. Profit margins in manufacturing vary around the world and between industries, but are generally much lower than in service industries. Net profit margins for manufacturers in developed Western economies tend to reach up to around 10% of revenues; service and software companies, in comparison, can deliver net margins upward of 20%.³ In India, manufacturing profit margins tend to be higher than the global average;⁴ whereas in China they tend to be somewhat lower than in the West.⁵ In an increasingly globalized market, the ability to enhance manufacturing productivity can make a fundamental and substantial difference to the financial performance of a manufacturer.

Respondents stressed that the cost components of manufacturing productivity vary between industries and countries. In some sectors, the ability to **reduce energy consumption** can lead to very significant economic efficiency. Milling, cooking, pumping chemicals and powering production lines all use considerable amounts of energy. One Siemens customer in the Scandinavian food industry was able to save over €700,000 per year at each manufacturing site by improving energy efficiency through digitalization. Although nondomestic electricity prices seem to have stabilized for the present, energy will continue to be a major cost-efficiency focus for manufacturers as governments continue to levy surcharges to fund the gradual conversion to renewable-energy generation.⁶

Other typical components of production efficiency include **reduced downtime** and **shorter setup and changeover times**. With digital sensors fitted to key parts of a production line to transmit real-time performance data to a central control system, performance can be optimized with subtle adjustments, and problems can be identified before they actually cause a loss in productivity or a shutdown. Such analytics enable predictive maintenance: part replacement and equipment servicing happens during planned periods that have the least impact on production peaks and actually **reduce downtime**. Digitalization has also given companies the ability to offer customers mass customization – where smaller, highly individualized production runs can be processed at much the same cost as mass production – in the form of faster **setup and changeover** speeds. Calibrations, settings, tolerances and so on are all stored in a digital “brain” and implemented automatically, thereby eliminating manual, sequential and time-consuming setup processes.

“Digitalization is particularly important, as our plants haven’t known enough about their energy consumption and it is impossible to undertake [corrective] measures without the information [that digitalization enables].”

GERMANY (Automotive Parts)

MindSphere from Siemens

MindSphere is the centrepiece of a powerful IoT operating system with data analytics and connectivity capabilities, tools for developers, applications and services. It helps evaluate and utilize manufacturing data and gain breakthrough insights.

With MindSphere, Siemens offers a cost-effective, scalable cloud platform in the form of a Platform as a Service (PaaS) for the development of applications. Designed as an open

operating system for the Internet of Things, this platform makes it possible to improve the efficiency of plants by recording and analyzing large volumes of production data. MindSphere provides a solid foundation for applications and data-based services from Siemens and third-party providers, for example in the areas of predictive maintenance, energy-data management and resource optimization.

“Digitalization is important for our industry ... we need to balance investments, profits and market needs to determine the value that digitalization delivers”

CHINA (Food Processing)

Another principal component of manufacturing productivity is **improved product quality**. Using sensor data, companies can identify and rectify process imperfections that are causing production faults and radically reduce faults per million. For high-precision products in particular, where the price per product is high, this advantage has a significant beneficial financial impact. In the last few years, some Siemens customers have reduced their fault rates to virtually zero by using digitalized process control and/or design-to-production simulation.⁷

The value derived from digitalization is not limited to the production environment: Digitally linking data across the enterprise as well as with partners involved in the supply chain and the distribution chain **improves planning and forecasting**, which delivers considerable cost and competitive advantages. The component features of improved planning and forecasting will vary between countries and industries. Two largely constant factors for all manufacturers, however, are the cost efficiencies derived from **reduced inventory holding** and **reduced waste**. This is the case because digital data analysis matches production much more closely to actual and predicted fluctuations in market demand. If innovative technologies such as additive manufacturing (3D printing) are deployed, then the spare-parts inventories in industries such as aerospace, energy and other high-value precision-component industries can literally be reduced to zero. Spare parts, including from decades-old historical back catalogues, are individually manufactured only when they are required.

Some benefits of digitalization have obvious value, yet precisely valuating the benefits may be more challenging in strictly financial terms. This is particularly the case with some areas of digitalization enhancement that **improve competitiveness**. A good example of one such competitive enhancement is digitalized technology that helps **reduce time to market**. The ability to speed up product development clearly helps an organization stay ahead of competitors and introduce product innovations that drive market share and new marketplaces. Product Lifecycle Management (PLM) software⁸ typically drives reduced time to market, first by providing a virtual environment for rapidly testing products and production processes, then by providing dashboard control and management over the end-to-end manufacturing environment.

“When we acquired digitalized technology, we were looking for innovative and modern solutions that would increase production. And we see our company growing as a result because the process of production is now faster.”

POLAND (Laboratory Device Manufacturing)

Digitalization also underpins manufacturers' **financial sustainability**. Savings and economies of scale derived from increased manufacturing productivity can be applied elsewhere by the company. A few examples include enhanced profits for shareholders, increased R&D to deliver future innovations, marketing and distribution initiatives to grow market share, more competitive pricing for customers or a mixture of all these. Overall improvement in competitive positioning can be the result, enhancing a business's market position while simultaneously supporting profitability – a key component of financial sustainability.

Putting a financial value on digitalization: The Digitalization Productivity Bonus

The various categories of value derived from digitalization that were highlighted in the previous section are compelling and have already been realized by a range of pioneering manufacturers. Some elements, however, are challenging to translate into a precise financial amount. Competitive advantage from greater turnaround agility or mass customization capabilities are clearly of value; yet these are more difficult to precisely quantify. One exception is increased manufacturing productivity, where the ability to either produce the same number of products for less or more products for the same cost, has a clear and calculable positive effect on costs (and, accordingly, on margins).

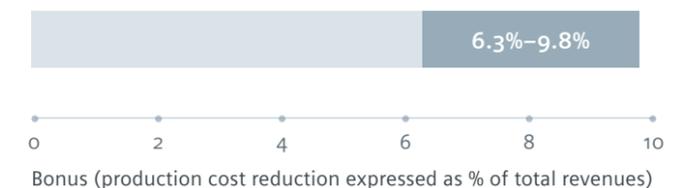
This paper will refer to amounts that can be released through **increased manufacturing productivity** as the *Digitalization Productivity Bonus*.

This research report consulted over 60 international industrial companies, expert management consultancies and academic specialists based in 11 countries around the globe. Each gave his or her expert estimate of the potential financial benefit that conversion to digitalized technology could deliver to manufacturing organizations,⁹ specifically in terms of **increased manufacturing productivity**. Production productivity is defined as a reduction in the cost of production – or, conversely, an increase in margins. Respondents assessed this reduction in production costs – the *Digitalization Productivity Bonus* – and expressed this as a proportion of total revenue.

The estimated global average percentage of financial gains is shown in figure 2.

To express the *Digitalization Productivity Bonus* as a financial amount, the average “bonus” percentage range was applied to the total annual revenue of different industries around the world (revenue data sourced from third-party research, trade associations, government statistics, etc., as appropriate). The subsequent total represents an estimate of the potential financial gain across an entire industry resulting from digital transformation and consequent improvements in manufacturing productivity.

Global Digitalization Productivity Bonus: Figure 2
reduced production costs resulting from conversion to digitalized technology



In the global plastic-products and packaging manufacturing industry, it is estimated that conversion to digitalized technology could deliver a Digitalization Productivity Bonus of between \$34 billion and \$53 billion.¹⁰

The Digitalization Productivity Bonus: In the words of the manufacturer

Of course, manufacturers only gain the *Digitalization Productivity Bonus* once they have upgraded production technology to the new generation of digitalized systems and equipment and have, as a result, realized the benefits in practice. The new technology delivers reduced production costs that can then be diverted to invest in growth or to return more value to shareholders.

International manufacturing companies were also invited to comment on their individual experiences with converting to digitalized (“fourth-generation”) equipment and technology in terms of the manufacturing productivity gains they had already been seeing from this investment. Selected comments are provided in figure 3 opposite.

Respondents’ comments reflect our research model’s finding: namely that companies are seeing financially measurable gains from **improved manufacturing productivity** that result from investing in fourth-generation digitalized technology. The benefits gained accurately reflect our key points of value and, broadly speaking, are being applied according to such organizational priorities as enhancing profit margins, developing competitive capabilities, offering better pricing, conducting improved forecasting and planning to reduce under – or overproduction, and investing in new product development.

Metal Machining (Germany) 	<i>“As we implement and ramp up our fully digitalized and automated smart factory, we are on course to improve productivity – the actual cost efficiency of producing each product – by around 30% within five years.”</i>
Food Industry (UK) 	<i>“Our digital factory investment is already delivering our target of adding just under five percentage points to our margins, making us one-and-a-half times as profitable in those parts of the business.”</i>
Microbiology Products (US) 	<i>“Thanks to the digitalization and automation that fourth-generation manufacturing tech has brought us, along with the analysis and scrutiny discipline that brings with it, our net margins have gone up by 50%.”</i>
Machinery (Spain) 	<i>“Since we have adopted IoT digitalized equipment, we have increased our product quality and our production efficiency by 25%. RFID sensors on our production lines have basically made it possible for so much improvement to maintenance, production management, incident escalation, production-efficiency monitoring and more.”</i>
Electrical Equipment (France) 	<i>“Efficiency from our investment in Industry 4.0 is putting a nine figure sum on our bottom line by 2020, increasing our EBIT by almost one-third.”</i>
Transport (Poland) 	<i>“Our project plans – and there’s already evidence to prove we are ahead of schedule – expect a threefold return on investment from our digitalization investment that started in 2014 and will be finished by 2020. That additional efficiency will then go straight to the bottom line year after year from then on.”</i>
Electrical Technology (Turkey) 	<i>“By transforming our environment to IoT and digital, we increased production visibility and real-time measurement. This, in turn, has already increased production-floor productivity more than 10% ... and we’re sure there’s more efficiency improvement to come.”</i>
Precision Parts (Russia) 	<i>“3D Printing and equipment digitalization has radically affected our production costs – halving them or, in some cases, reducing them by even more. Of course the price of production is not the larger share of cost in our business; but by modernizing away from traditional component production methods, we have transformed our competitiveness and profitability at home and on world markets.”</i>
Micro-processors (China) 	<i>“Our digitalized production system aggregates and centralizes manufacturing-progress data collected through sensors and other IoT devices. To process and analyze the accumulated big data in real time while maintaining high-level security, a big-data analysis platform was built that enables warning signs about problems in equipment to be detected. The result has been a 10% improvement in our yield (productivity) when measured as a proportion of total revenue.”</i>
Pump Manufacturer (India) 	<i>“The digitalized smart factory has transformed our forecasting and planning. We have seamlessly connected people, machines and materials – and the shop floor with the top floor – while using real-time information from the production line and automated workflow triggers delivered through personalized mobile dashboards. Our downtime has dropped by 20% and our productivity has risen by 20%.”</i>
Power Products (Sweden) 	<i>“Prior to our investment in digitalization and robotic automation, employees were needed to operate the machines all the time. Now our new automated production technology has improved our productivity – while at the same time increasing our (production) efficiency by between 20% and 25%.”</i>

Figure 3

Financing the *Digitalization Productivity Bonus*

While digitalization drives **financial sustainability**, access to a range of smart and appropriate financing techniques – Industry 4.0 Finance – is also critical to a company's ability to sustainably invest in the new fourth-generation of digitalized technology and automation equipment. Our research reveals a consensus among manufacturers: Without appropriate finance, they cannot sustainably invest in digitalized technology.

This is where specialist financing techniques come into play. Financing techniques have now been developed to allow an organization to in effect apply some or all of the *Digitalization Productivity Bonus* to fund the digitalized technology and equipment that makes the bonus possible in the first place. In simple terms, these financing methods seek to align payments for the new generation technology with the rate of gain from the *Digitalization Productivity Bonus*. Broadly speaking, this can help make the upgrade to digitalized technology affordable and potentially cost neutral (or better) for the manufacturer. In fact, for much of the global manufacturing sector, the rate of conversion to digitalization is expected to be determined by the availability of these specialist financing techniques – and particularly for companies that do not have a means of

financing these improvements themselves. So specialist finance can serve as a key enabler for manufacturers to access the *Digitalization Productivity Bonus*; in turn, the *Digitalization Productivity Bonus* contributes to a company's future financial sustainability once the digitalized technology upgrade has been realized. An overview of specialist financing methods – that is, Industry 4.0 Finance – is provided in the next section of this report.

Each manufacturer will have its own priorities on how the *Digitalization Productivity Bonus* is applied in their organization. Respondents to this report have outlined a number of key strategic possibilities for applying the bonus. They include:

- Returning value to shareholders by increasing current profit margins
- Investing more heavily in R&D and new product development to maintain market share and penetrate new markets
- Sharing, in effect, part of the *Digitalization Productivity Bonus* with customers by investing in more competitive product pricing and market-share building

'Think digital': A new mindset

It is frequently said that moving to digitalization – to Industry 4.0 – is not simply a matter of transforming the technology platform; it is also about adopting a new "digital mindset."¹¹ Industry observers tell us that this can mean many things: designing processes with automation in mind; developing a wide range of individualized, not mass-produced, products; structuring business units in a modular way for agile reaction to local or market trends; designing management structures and responsibilities that fit the new digital world; incentivizing collaboration; recruiting and regularly up-skilling digital talent; and more.

Financing also requires a similar change of mindset to provide effective, sustainable ways of implementing digitalization – a specialized portfolio of financing techniques that this report is calling Industry 4.0 Finance. At the top level, effective Industry 4.0 Finance has to factor in tomorrow's benefits to fund today's investments. That means the organizations offering Industry 4.0 Finance need to have an expert understanding of what those benefits are expected to be. How else can they reliably develop financing solutions that address the practical adoption of Industry 4.0? This means financiers are moving away from the old world of financing a technology investment and more toward financing business outcomes. An intimate understanding of how digitalized technology works in practice as well as how it creates successful outcomes is clearly essential.

What are Industry 4.0 financiers offering that supports this new mindset?

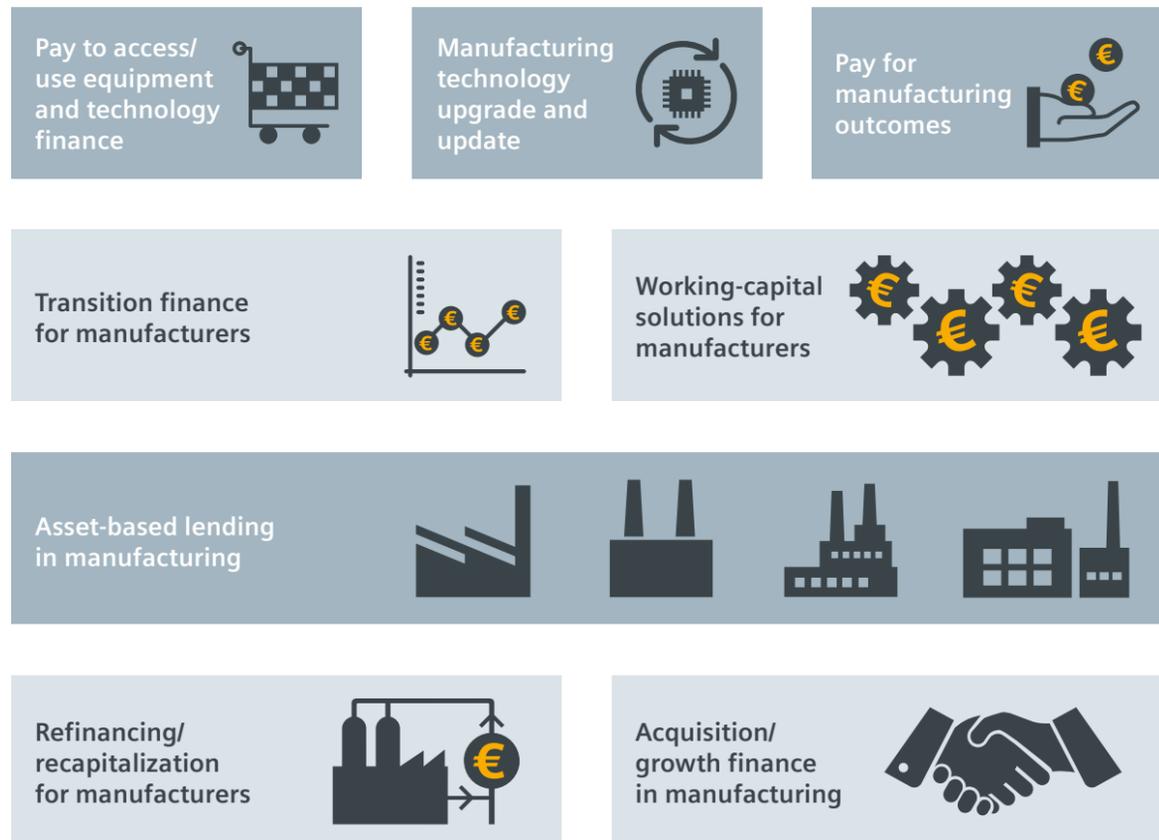
- Industry 4.0 Finance can:
 - Embed financing options into the initial value proposition, opening a wider range of affordable digital transformation possibilities
 - Flex financing periods to suit the pace at which each manufacturer will reduce costs or increase sales as a result of the company's digital transformation
 - Cover the total solution and total cost of ownership (hardware, software, services), allowing manufacturers to secure digital transformation at a guaranteed and sustainable monthly cost
 - Employ machine data to ensure finance is based on usage or outcomes, aligning technology capabilities with their resulting commercial benefits
 - Use cost-saving or money-making outcomes to fund enabling technology, making digital transformation cost neutral
 - Build in technology upgrade options so manufacturers do not become trapped in technology obsolescence in a world of quicker innovation cycles
 - Bridge the cash-flow gap between technology investment and the resulting benefits to make digital transformation more financially sustainable

Financing digitalization: The tools

Ongoing research work¹² has identified a number of specialist financing methods that are being deployed by manufacturers looking to upgrade to the digitalized, automated operating platforms of Industry 4.0. The specialized range of financing techniques – which this paper is calling Industry 4.0 Financing – covers the gamut of requirements: from the acquisition of a single digitalized piece of equipment right through to financing a whole new factory; it even includes acquisition of a competitor.

Industry 4.0 Finance arrangements tend to be offered by specialist providers that have a deep understanding not only of how the digitalized technology works, but also of how that technology can be practically implemented to deliver the *Digitalization Productivity Bonus* as well as other benefits of digitalization. At times, the financing arrangement will be an embedded component of the value proposition, offered right at the beginning of the sales cycle. In other cases, the technology provider will refer its customer to one or more finance providers to fund a sale. Complete solutions should be taken into consideration in order to identify the best finance package to effectively digitalize a manufacturing facility's entire operation – from equipment to software to the production line to the whole enterprise.

Between them, this range of Industry 4.0 Finance techniques allows organizations both large and small to access the *Digitalization Productivity Bonus*. For this reason, it is worth taking a moment to briefly explain how each works.



ASR Industries

ASR Industries is a leading supplier of fixtures and customized engine parts to India's largest automotive companies. Two years ago the company witnessed increased demand, which required expansion of their production with the purchase of a VMC machine within one week. Their traditional route of bank financing was unable to meet this turnaround time, which was crucial since ASR risked losing 5% of new orders due to a lack of production capacity. Siemens Financial Services was able to provide a hypothecated loan within three days, enabling ASR to effectively address the increased demand and needs of their customers.

Chin Fong Machinery Industries

Chin Fong (China) Machinery Industries Ltd., a key partner of Siemens' Digital Factory Division (DF), is a specialist in metal-forming equipment. The company wanted to meet increasing financing demands from its customers. Siemens Finance and Leasing (SFLL) was able to provide a strategic agreement offering customized leasing solutions to the end users of Chin Fong (China). With the leasing solution from SFLL, Chin Fong (China) has been able to win business that could otherwise have been lost due to end-user budget constraints.

Pilkington

One of the UK's foremost glass manufacturers, Pilkington United Kingdom Ltd ("Pilkington"), a part of the NSG Group, has worked with Siemens to drive a major energy management project across its production sites. The program with Siemens is designed to enhance Pilkington's overall energy performance, cut costs and create a more sustainable future. The agreement enabling these projects to be realized comprised of an industry-leading energy performance contract between Siemens and Pilkington. The principle of the arrangement is that Siemens Financial Services funds the initial capital expenditure required for the projects, which have typical three-year payback periods in terms of generated energy savings. Pilkington then simply makes a monthly payment that matches its monthly savings in energy costs. This effectively results in a zero net cost investment, which not only modernizes the Pilkington manufacturing infrastructure but also sustainably reduces the company's carbon footprint.

Südzucker AG

Südzucker AG is Europe's biggest sugar producer. Because of the high energy intensity of sugar production, Südzucker is investing in energy-saving technologies that contribute to process efficiency and, ultimately, climate protection and sustainability. In order to achieve these goals, the Südzucker Zeitz plant in Saxony-Anhalt decided to optimize a fan system with a new Siemens drive. It was financed by Siemens Financial Services (SFS) using an energy performance contracting model. The monthly installments are adjusted according to the actual savings that result from the reduced energy usage. As a result, the company did not need to raise capital to acquire the technology. Südzucker is saving 930,000 kilowatts each year, or 680 tons of CO₂ emissions.

dpm Daum + Partner

dpm is a mechanical engineering company operating in the automotive industry, specifically in the field of automated guided vehicles (AGV). Siemens provides dpm with engines, Simatic control systems and switch cabinets. Due to the growing importance of AGV's, especially in the light of initiatives implemented by Google, Apple and Tesla, the demand for dpm products has increased. Major orders boosted dpm's purchasing volume, but the high demand was also challenging for the company. As most of the projects were ongoing, dpm would only receive payments in the medium or long term. To support the company's growth, Siemens Financial Services (SFS) and dpm agreed on a fine-trading financing model that allows dpm to extend payment terms for Siemens products. The solution is highly flexible as dpm can decide for each individual order whether an extension of payment terms is necessary. In this way, even major orders can be managed with a low financial burden.

Pay to access/use equipment and technology finance

Designed to enable the acquisition of a system or an item of technology or equipment, this will usually be some form of finance lease, operating lease, rental or hire purchase arrangement. Financiers with extensive knowledge of manufacturing will arrange the finance period and terms to align with the expected benefits the manufacturer will gain from the use of the technology. Often this type of financing will also cover associated costs of ownership, such as maintenance, via a bundled monthly payment. To enable easier ongoing acquisition decisions, a financier will often have some kind of master agreement with a manufacturer, streamlining the process of agreeing future finance.

Software finance

Although the transformation to a digitalized Industry 4.0 world is rarely a pure software investment, most solutions will involve both hardware and software. This is recognized by specialist financiers that have the capability of financing such requirements. Knowledge of software implementation and business outcomes the software is likely to produce allows these financiers to understand the associated risks and include the software element in an overall financing package.

Transition finance

While the benefits of moving to a digitalized manufacturing environment are clear, the process of transitioning has to be carefully managed and the commercial risk must be eliminated by rigorously testing the new technology in a real-world production environment. Recognizing the challenges of transitioning, specialist financiers offer financing arrangements that defer payment for a new system until it is up and running reliably. This removes the financial challenge of having to pay for the new system while the old one is still in place.

Technology upgrade and update

Since technology innovation and upgrade periods are shortening in a digitalized world,¹³ equipment and technology finance can also offer options to upgrade during the financing period, which offers protection against technology obsolescence. Upgrades might involve replacement with a newer model or retrofit enhancements onto the main technology platform.

Pay for outcomes

Increasingly, financing agreements are being set up in which payments are predicated on the expected business benefits, or "outcomes," the technology makes possible.¹⁴ Savings or gains from access to the technology are used to, in effect, meet monthly payments, making the technology costneutral for the manufacturer over time. A good example is where energy-efficient equipment delivers cost savings from lower energy consumption, and a financing plan aligns payments to the rate of savings made each month.

Working capital solutions

Cash-flow and working-capital challenges not only arise at the point of acquiring digitalized technology. Digitalization may increase production capacity and productivity while improving price competitiveness to the extent that a manufacturer's order book experiences an unexpected and/or significant upswing. This is positive, but can bring its own challenges with it: for example, a manufacturer may suddenly have to buy greater quantities of raw materials or component parts. Financing services – usually based on some form of invoice finance – are available to help manage the cash-flow challenges that success through digitalization brings.

Asset-based lending

With digitalization, manufacturers may experience tightened liquidity due to rapid growth. Asset-based lending allows a manufacturer to access cash that may be tied up in capital assets. A revolving line of credit secured by the manufacturer's accounts receivables and inventory provides the liquidity needed to meet daily cash needs. The manufacturer could use the cash to help fund ongoing operations, growth, acquisitions or restructuring as a result of digitalized upgrades.

Refinancing/recapitalization

A manufacturer may need to manage debt or may experience a change in financial ownership. Financiers offer term loans and revolving credit facilities so manufacturers can adjust their capital structures to improve debt, make distributions to shareholders and facilitate ownership changes that lower the overall cost of capital. With digitalization, manufacturers could grow out of their legacy capital structures and may need to refinance debt at more competitive rates.

Acquisition/growth financing

Manufacturers who invest in digitalization will reap the benefits, taking market share from those who do not. Growth by acquisition will, on occasion, make good business sense for these digital winners, whether to acquire ailing competitors or make strategic moves into new geographies and markets. In these situations, manufacturers can leverage services from financiers offering tailored corporate-loan facilities and revolving credit for daily corporate use and for strategic growth. Sometimes these are issued in the form of multilender syndicated facilities.

AK Steel

It is AK Steel's mission to become North America's premier steel manufacturer. The company is focused on expanding its production capabilities and modernizing its products and, therefore, wanted to acquire Russian steelmaker Severstal's operations in Dearborn, Michigan, US. This would improve the company's access to automotive customers. AK Steel required \$1.5 billion to facilitate the acquisition. Siemens Financial Services committed \$100 million in a multilender working capital facility to ease AK Steel's acquisition of the Severstal facility. As a result, the company was able to increase its shipment capabilities by more than 40%, improve operational flexibility and increase scale to better serve customers.

Modern Dental

Established over 30 years ago in Beijing, China, Modern Dental is a leading global manufacturer and provider of dental prosthetics. Modern Dental wanted to refinance its core debt, provide business flexibility through a working-capital facility, and build a new plant in China following its initial public offering (IPO). To facilitate these requirements, Siemens Financial Services supplied \$25 million of an \$85 million credit facility provided with three other financial institutions.

Intas

Intas is a top-12 Indian pharmaceutical company and has operations covering research, manufacturing and formulation development. The company's products are marketed in over 70 countries including in the US, Europe, Central and Latin America, Africa, Australia, New Zealand, Asia-Pacific and MENA countries. As part of a syndicate, Siemens Financial Services provided a credit facility of approximately €710 million that allowed Intas to acquire Actavis UK from Teva Pharma in 2016. Actavis manufactures and distributes generic pharmaceutical products to the UK.

Sector focus: Food & Beverage

The value of digitalization really comes alive when described in terms of a specific industry and its challenges, processes, and opportunities. In this section, our report examines some of the ways Industry 4.0 is being applied in the Food & Beverage industry, a sector that is economically significant across the world.

To provide an idea of the scale of benefit Industry 4.0 can provide the Food & Beverage industry, this paper has applied its *Digitalization Productivity Bonus* model to the industry in 11 countries around the world. The average bonus percentage range was applied to total annual revenue around the world (revenue data derived from official third-party sources). The resulting financial totals in figure 4 estimate how much the Food & Beverage industry could gain from improvements in manufacturing productivity as a direct result of digital transformation.

The *Digitalization Productivity Bonus* is, however, only one aspect of value that digitalization delivers to the Food & Beverage industry. Research conducted for this report reveals that there are a number of key focus areas where digitalization and automation create value in the sector. A selection of these is described below.

Reaching down the food-supply chain, we see that agricultural production benefits from digital data. In the food-processing industry, information on the expected quality of an ingredient might be available even before harvest (e.g., on the basis of data on weather conditions). This information will be relevant for adapting manufacturing processes or sourcing other ingredients.¹⁷

Another area where Industry 4.0 can help is with food quality. Shelf life is undeniably a real issue for many food manufacturers; and for businesses that make fresh products the same day they are shipped, it is important to not overproduce.¹⁸ Digital information flowing up and down the distribution and supply chains improves coordination of supply and demand (which may fluctuate as frequently as each day) to guard against overordering and overproducing. Electronic traceability allows producers to track items from delivery to the supermarket shelf. This is about connecting engineering to production to IT in order to support joint systems and more efficient demand and production planning.¹⁹

In the global food & beverage manufacturing industry, it is estimated that conversion to digitalized technology could deliver a Digitalization Productivity Bonus of between \$290 billion and \$450 billion.¹⁶

Estimated Digitalization Productivity Bonus: reduced production costs resulting from conversion to digitalized technology in the Food & Beverage industry¹⁵

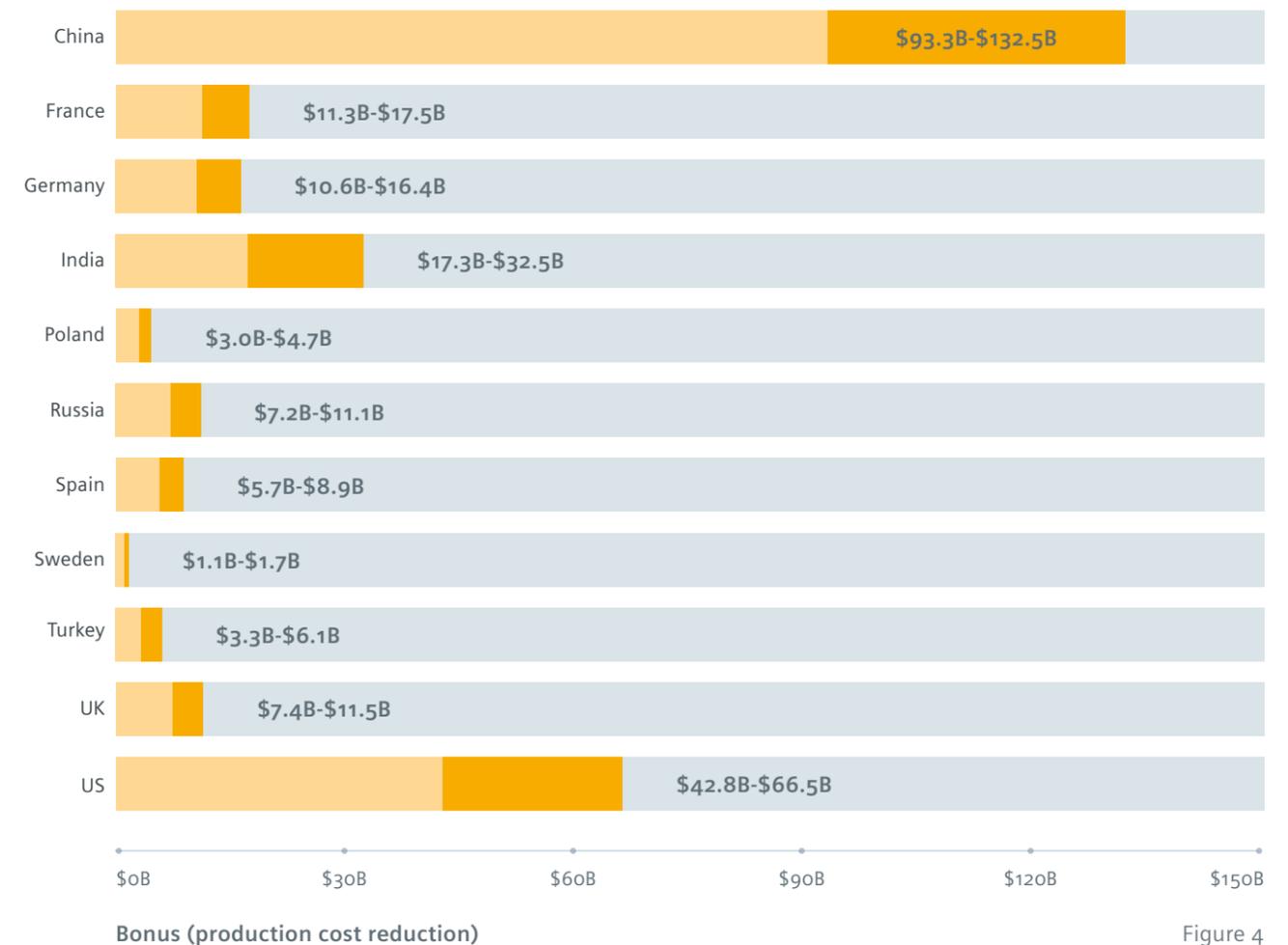


Figure 4

From field to factory



Other benefits from digital supply-chain integration include connecting communities and technology through a cloud-based platform. Food Industry 4.0 allows businesses to take a product to market more quickly by connecting the supply chain to the production facility through interoperability. Uncovering patterns in data also allows businesses to actually anticipate customer demand – enabling businesses to harness analytics and further refine their processing solutions.²⁰

One industry observer notes that Food Manufacturing 4.0 introduces highly flexible “lights-out” (totally automated) manufacturing that enables new economies of production.²¹ One example is a food company’s palletizing and depalletizing systems that run on a “lights-out” basis. A forklift automatically loads the system with individual cases and robots pick the cases, put them into place, and stack them onto pallets. These pallets are then stacked on top of one another in a dedicated area. Sensors detect when space is running out and only then is human intervention triggered.²²

The results include reduced personnel costs and optimized personnel deployment, reduced human error, higher process accuracy, automatic monitoring and audit information, and automated action triggers for optimized uptime.

Digitalization also permits the optimization of preventive maintenance programs so expensive and delay-inducing machine failures are all but designed out. A good example is industrial bakery ovens, which operate on very tight “fresh-bake” delivery schedules. Oven failure at times of peak production can be absolutely disastrous for customer relationships, so predictive preventative maintenance enabled through sensor-derived data analysis is a critical commercial risk-management benefit.²³

Connected and communicating production machinery reduces wastage. This enables more flexible production with shorter swap-over times, provides greater energy- and machinery-utilization transparency and improves overall equipment effectiveness (OEE) and other key performance factors.²⁴

One global confectionery manufacturer has been quick to leverage the benefits of additive manufacturing – 3D printing, a hallmark technology in the digital factory, employing it as part of their new product-development process. The company has been able to turn their ideas into 3D models and then into edible prototypes within a matter of days. Innovating the new product-development process in this way has allowed the company to create and test prototypes more rapidly and cheaply than any of their competitors and has positioned them as a leader in their field.²⁵

Packaging is another area to benefit from smart factory technology. Working with a crowdsourcing platform, a major global beverage company gathered data on customer product labeling ideas. Participating customers were then able to order the product in small quantities with their own label configuration. This “mass customization” was only possible and affordable using digitalized Industry 4.0 print and dispatch technology. Not only is this a good example of mass personalization, it also shows technology being used to build brand image and customer relationships.²⁶

The chain of digitalization continues in the factory, where it’s imperative the cold or hot chain is not interrupted while the product is being processed otherwise whole batches of food could become unusable under certain conditions. IoT monitoring of fridges and other temperature-controlled environments is critical, with automated alerts and escalation routines making it possible to quickly identify and rectify irregularities.²⁷

In an industrial kitchen there are strict rules – for instance, the temperature of warm food may not fall below a very precise temperature so the danger of bacterial growth is eliminated. Smart transport containers in the delivery chain help monitor the food temperature and add heat when necessary.²⁸

Logistics and goods or materials handling are major areas that derive value from digitalization. Automatic guided vehicles (AGVs), once the domain of manufacturing operations like automotive plants, are making their way into the Food & Beverage industry and consumer packaging applications, replacing human-operated forklifts for moving raw materials and finished products around the food-processing plant and redeploying and reskilling staff. Although the fundamental purpose of automated vehicles is to more cost-effectively move materials in a plant, these vehicles offer other benefits as well, including reduced product damage, reduced inaccuracies, and reduced safety risks.²⁹

One industry observer described an even more futuristic vision about how Food Industry 4.0 factories will interact to create significant economic advantage. While today’s food-industry systems are centrally controlled, in the future machines and raw materials will use information and communication technologies to similarly communicate with a social network and independently organize production across company boundaries.³⁰



Sector focus: Pharmaceuticals

As with the Food & Beverage industry, this paper also applies its research-based model to the Pharmaceutical manufacturing industry in each of 11 countries to provide an estimate of the *Digitalization Productivity Bonus* to be gained by the sector as a result of investment in digitalized Industry 4.0 technology. The average bonus percentage range has been applied to the total annual revenue of the Pharmaceutical industry in selected countries across the globe (official data on revenue was taken from official third-party sources). The resulting totals in figure 5 are an estimate of the potential financial gain for the Pharmaceutical industry as a direct result of improvements in manufacturing productivity from digital transformation.

In the global pharmaceutical manufacturing industry, it is estimated that conversion to digitalized technology could deliver a Digitalization Productivity Bonus of between \$67 billion and \$105 billion.³²

As noted in the previous section, the *Digitalization Productivity Bonus* is a critical starting point for CFOs in the Pharmaceutical industry. Nevertheless, there are other commercial benefits that also accrue from the move to digitalization. Drawing on qualitative research conducted for this report and specific industry examples, this paper illustrates how digitalization and automation are creating value in the sector.

Pharmaceutical plants typically experience high levels of downtime. According to one analyst, digitalization and data analytics could reduce this downtime by 30% to 40%³³ significantly improving overall equipment effectiveness (OEE). IoT communication between machines and machine-learning artificial intelligence (AI) deliver seamless processes, predictive maintenance and automatic corrective actions.

The pharmaceutical manufacturing environment is highly sensitive and tightly regulated. The smallest of errors can result in life-changing patient outcomes and have a disastrous commercial, legal and reputational impact on the manufacturer. For these reasons, "Pharma 4.0" can often deliver amplified operational and competitive value.

Estimated Digitalization Productivity Bonus: reduced production costs resulting from conversion to digitalized technology in the Pharmaceutical industry³¹

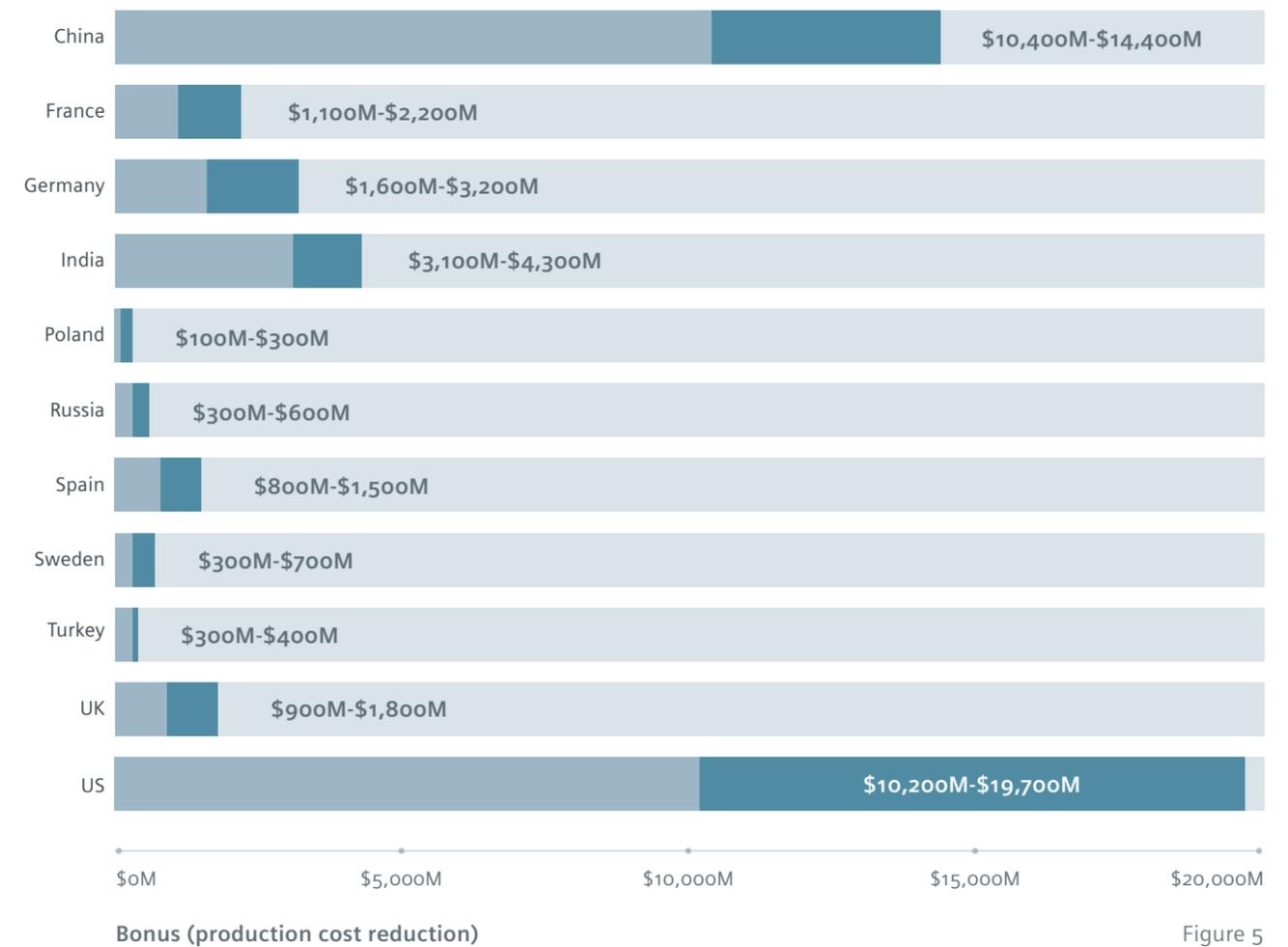
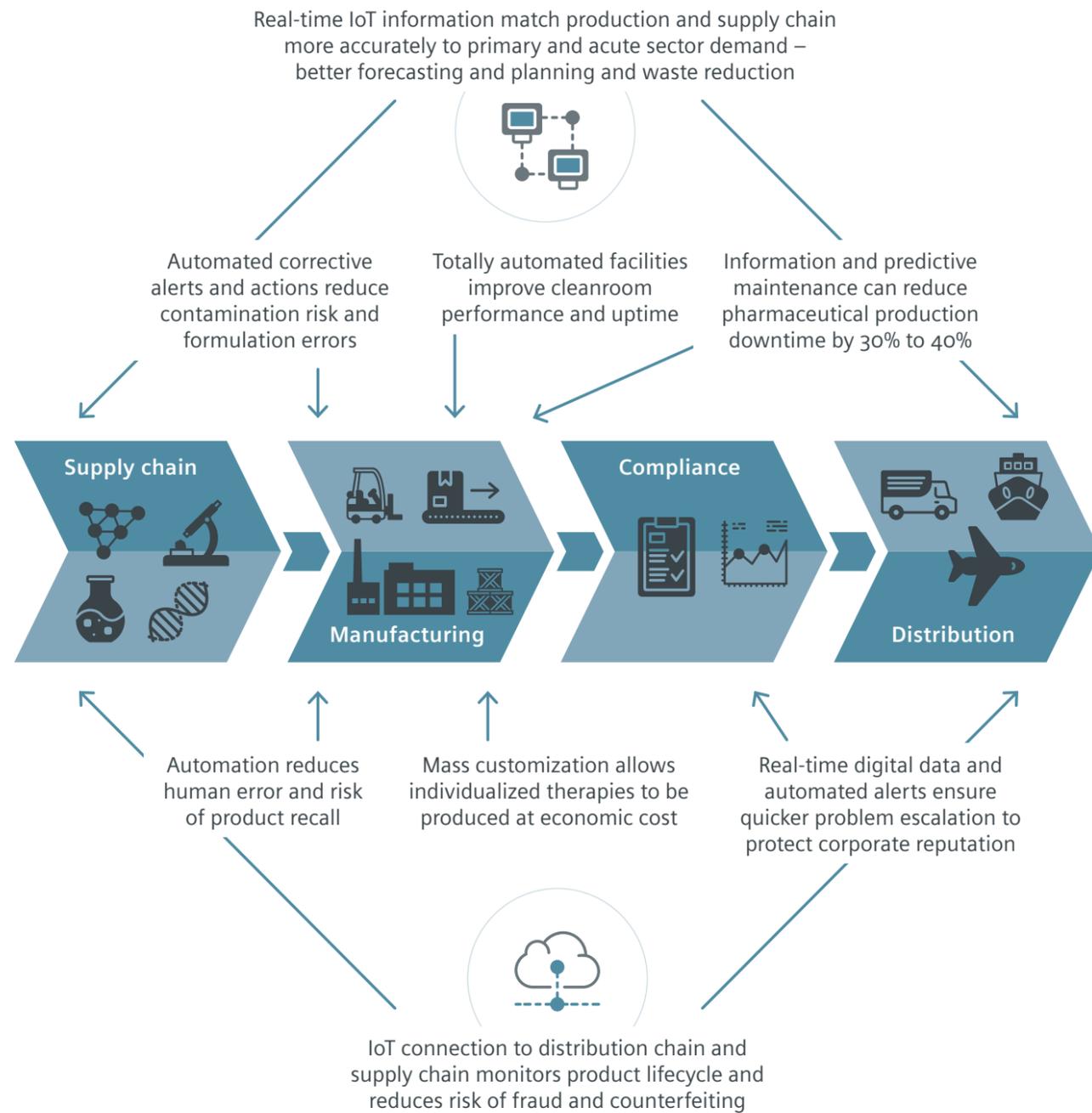


Figure 5

From chemistry to customer



A few years ago, a global pharmaceutical giant had to recall over a half a million tablets because of packaging and human-monitoring errors in the plant.³⁴ Digitalization and automation are now ensuring the company will not experience a similar error in the future and suffer the financial ramifications and negative brand impact it suffered in the past. By introducing digital sensors and robotics and investing in high-availability computing to guard against data-transfer issues between units, the

company has created a fully automated production line that has the by-product benefits of making it much easier to maintain cleanroom processes, capture and manage electronic batch records, and analyze process performance (through root-cause analysis) to identify and implement improvements.

Further points of value for Pharma 4.0 are being gained in the field of regulatory compliance. One manufacturer has installed digital sensors for visual, environmental, temperature, and chemical monitoring throughout its manufacturing process.³⁵ This has now automated compliance reporting that previously involved expensive manual monitoring, although half-yearly manual tests are still made by an outside agency to audit and verify the automated reporting. Not only has this released crucial funds for investment elsewhere in the business, it has also provided the means for alerts when any of these factors move outside of defined tolerances, triggering early intervention that minimizes the cost of potential contamination, formulation errors, and consequent process shutdowns.

Mass customization is also important to the pharmaceutical sector in light of the increasing trend of individualized formulations. Although individualized-medication manufacturing raises important issues about quality, batch stability, and risk management, some areas may benefit from being able to manufacture short runs of customized therapies at the kind of price previously associated with mass production. One manufacturer is currently trialing such digitalized processes with analgesic combinations.³⁶

Digital integration of the distribution chain (through distributors, then pharmacists and retailers, to the clinician and patient) offers pharmaceutical companies greater opportunities to combat fraud. One generics manufacturer³⁷ became aware of several counterfeit versions of its products in certain countries. The company introduced an encrypted digital signature to its packaging that allowed genuine products to be tracked and traced down the distribution chain, with healthcare organizations able to verify the product through a secure portal in the cloud.

Digital information integration up the supply chain and down the distribution chain is also delivering greatly enhanced demand-supply management. One manufacturer that supplies a wide range of therapies in a single particular location.³⁸ Links to these hospitals' clinical information systems enables the gathering of aggregated anonymized patient data in a selection of specialties and uses predictive analytics to better plan manufacturing production volumes. This pilot has already demonstrated high levels of accuracy and is planned for gradual rollout across the country through to 2020.

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8. Such as Siemens PLM software.
9. See note 1; N.B. exclusions: oil refining, smelting, heavy chemicals and other mega-energy industries.
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