

Are Manufacturing Companies Ready to Go Digital?

Understanding the Impact of Digital



Executive Summary

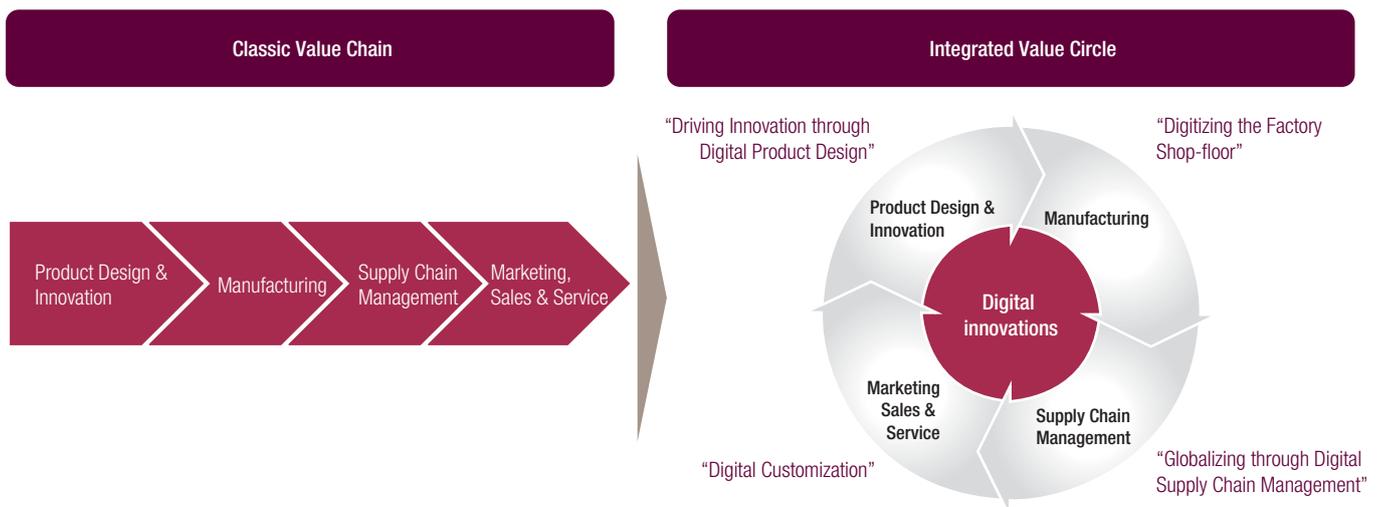


Manufacturing companies have traditionally been slow to react to the advent of digital technologies and their related impact across the manufacturing value chain and operating model. While there are a few manufacturing companies that have made rapid advances in deriving significant benefits from digital, their number is still small. For instance, in a recent industry survey, only 25% of the interviewed executives believed that the manufacturing sector would be highly impacted by digital transformation over the next five years. Our study found that digital innovation is critical when it comes to addressing manufacturers' key business drivers and creating value.

Digital capabilities help manufacturing companies to exchange large amounts of data rapidly, store local data centrally without limitations, enrich processes with digital expert knowledge, generate valuable insights from this "big data" and facilitate communication and collaboration through digital channels within their value chain. These new capabilities transform the classic value chain into an integrated value circle (see Figure 1). This new value circle leverages a tighter integration, automation and acceleration of internal operations, local execution of work that is coordinated and consolidated on a global level and ensures comprehensive business knowledge and transparency.

We found that the impact of digital technologies and the corresponding maturities of manufacturing companies vary by the sub-sector that they are present in. The sub-sector also determines which part of the value chain that companies need to focus on. For instance, the more business-to-business (B2B) focused sub-sectors aerospace & defense and industrial products are impacted more in areas of operations, such as product development, manufacturing and supply chain management (SCM). Similarly, automotive OEMs and parts of the high-tech industry that have a clear focus on business-to-consumer (B2C) business models are impacted more in

Figure 1: Transformation of the Classic Value Chain



Source: Capgemini Consulting analysis

areas of product innovation, marketing, sales, customer relationship management and service (see Figure 2).

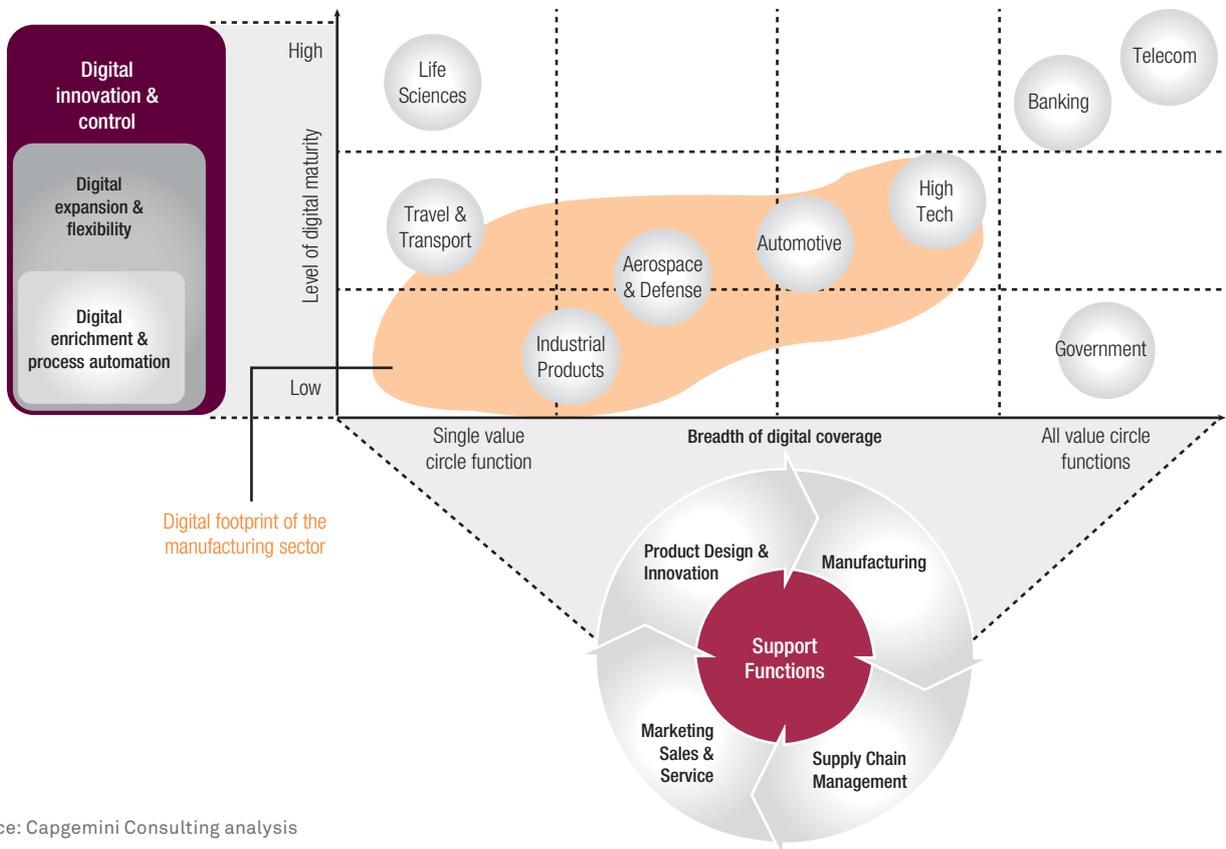
When properly exploited, digital technologies can help manufacturers turn into highly innovative, fast-growing and agile companies. Product development experiences a significant increase of innovative power through open innovation and collaboration within integrated competence networks. In the manufacturing area, digital tools help companies to increase the productivity and agility of their factories to new levels. Digital supply chains can cover even remote spots in a highly efficient way. Digital tools in marketing, sales and services can boost effectiveness, revenues and margins in global markets. Internal support functions can be digitally embedded into the value chain.

Beyond the digital value chain integration, manufacturers can leverage digital opportunities by transforming their global business and operating models to raise synergies and efficiency gains. This can be achieved through an appropriate degree of centralization while keeping and strengthening local presence, flexibility and entrepreneurial spirit in the different divisions and countries. Using digital technologies, cross divisional sales and service operations, global supply networks, shared functions and services as well as an optimized profit and cost allocation and control model with appropriate target systems can be effectively and efficiently established in manufacturing companies operating around the globe.

We found there are several digital innovations that impact manufacturing companies to varying degrees. These include collaboration platforms, analytics, social networks, rapid manufacturing, virtualization, cloud computing and crowd sourcing.

We believe manufacturing companies will need to adopt a systematic approach to address digital opportunities across the manufacturing value chain and operating model. In order to build a cohesive digital roadmap, they should take a four-pronged design-innovate-prioritize-implement approach.

Figure 2: Digital maturity of the manufacturing industry - Illustrative



Source: Capgemini Consulting analysis

The Need for Digitization

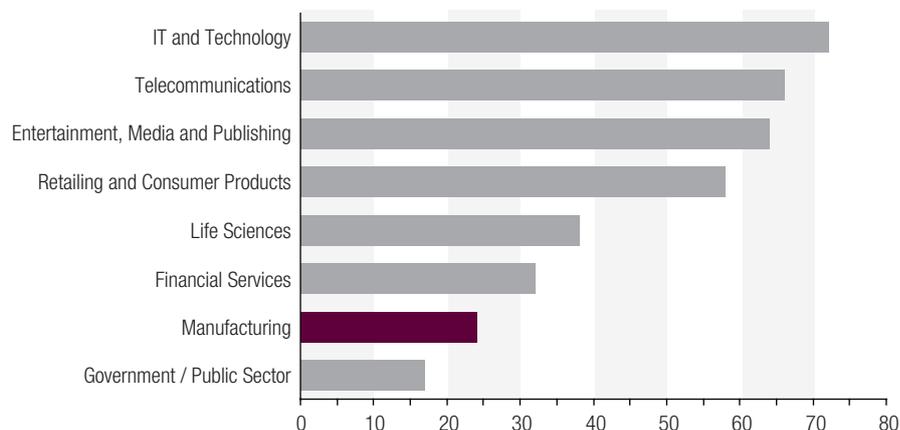
Digital technologies have started impacting corporate performance across industries. Organizations are now realizing the disruptive and productive impacts of digital on their operations. However, it looks like most manufacturing companies are yet to be convinced of the value-accreting benefits of digital and have preferred a wait-and-watch approach. For instance, in a recent industry survey, only 25% of the interviewed executives believed that the manufacturing sector would be highly impacted by digital transformation over the next five years (see Figure 3). While there may be some truth to this since the manufacturing sector is typically characterized by complex processes, legacy systems and legacy thinking, we believe that there are areas in the manufacturing value chain and operating model which can be radically transformed by digital.

In today's highly competitive environment, digital innovation is critical when it comes to addressing manufacturers' key business drivers and creating value. These key drivers include the potential to cut costs, increase productivity, shorten time-to-market and increase customer focus (see Figure 4).

In order to obtain an overview of the current state of the art regarding digitization and its tools and methods, and to identify key digital opportunities in the manufacturing industry, Capgemini Consulting conducted research looking into the practices of more than 80 global manufacturers in the aerospace & defense, automotive, high tech and industrial products segments. This study was designed to examine how digital innovations can enable business benefits within the manufacturing industry.

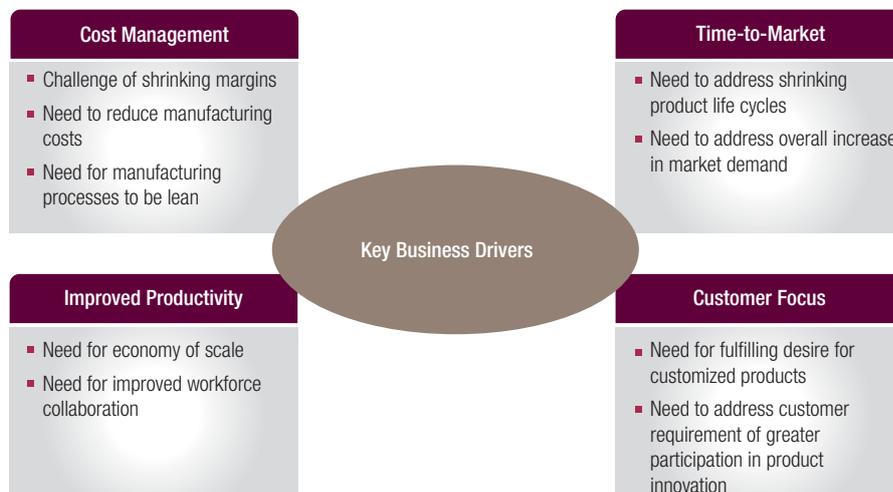
Figure 3: Industries most affected by Digital Transformation

In your view, which of the following business sectors will be most transformed (for the better) by information technology over the next 5 years? (% stating "greatly transformed")



Source: Oxford Economics (2011): "The New Digital Economy – How It Will Transform Business", global survey of 363 business executives across industries

Figure 4: Key Business Drivers for Manufacturing Companies



Source: Capgemini Consulting analysis

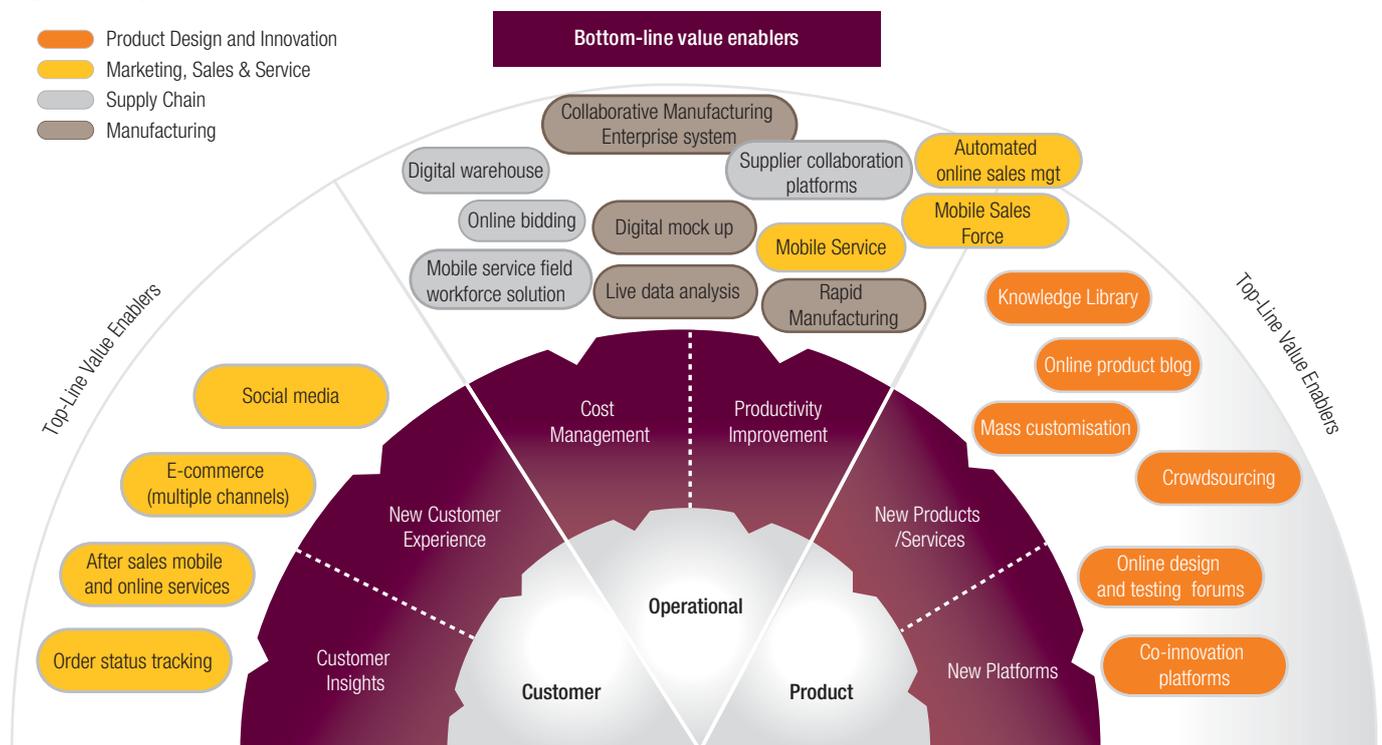
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Only 25% of industry executives believe that the manufacturing sector would be highly impacted by digital transformation in the next five years
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A key outcome of our findings is what we term an “Innovation Radar” of the manufacturing industry. This representation clusters the enabling digital tools and methods to the areas of bottom-line as well as top-line opportunities to improve and optimize the manufacturing businesses (see Figure 5).

In the remainder of the paper we identify digital innovations, trends and associated opportunities along the value chain. We also take a look at how digital technologies can alter the operating model and then provide a methodology that manufacturing companies can leverage to create a digital roadmap to support their business objectives.

In the next section, we take a look at how digital technologies, such as those shown in the below Digital Innovation Radar, are impacting the manufacturing value chain.

Figure 5: Digital Innovation Radar



Source: Capgemini Consulting analysis

“*Capgemini Consulting conducted research looking into the practices of more than 80 global manufacturers*”

Digitizing the Manufacturing Value Chain

Digital tools and technologies allow manufacturing companies to reduce costs, increase productivity, achieve faster time-to-market and increase customer focus across various elements of the value chain. In this section we look deeper into the digital tools that can be used by manufacturers for each stage of their value chain (see Figure 6).

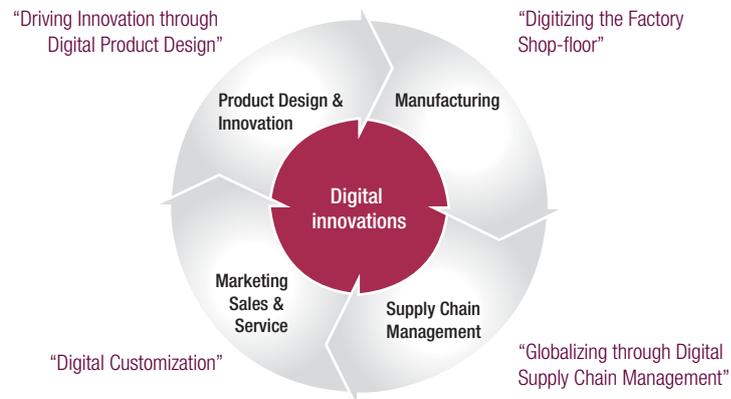
Driving innovation through digital product design

Digital tools can have a significant impact across the key stages of ideation, product development and testing and help accelerate product development and reduce costs at the same time (see Figure 7).

The connected nature of digital technologies enables the usage of techniques such as **open innovation, co-creation and crowd-sourcing**. They can be useful for **generating ideas towards innovative solutions, accelerating product development** and addressing the rapidly changing market conditions.

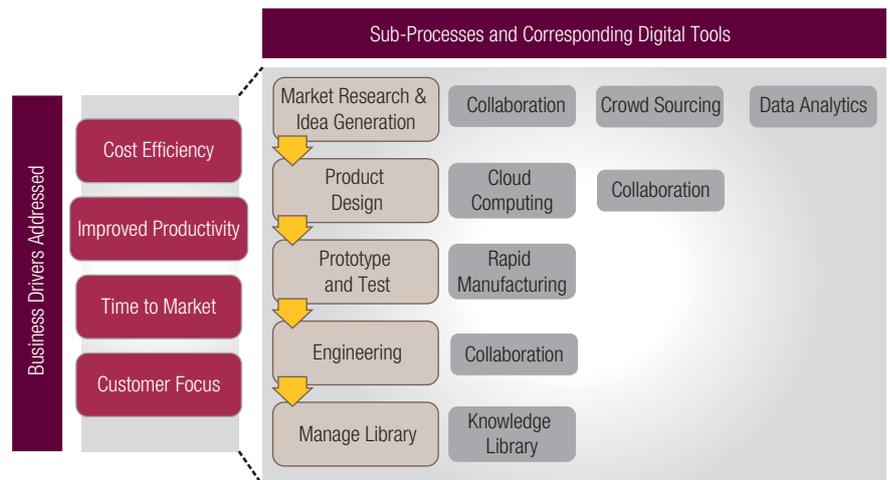
For instance, as a part of its innovation initiative, General Electric wanted to involve all stakeholders including customers, current and prospective, and internal engineers in developing a sustainable solution for an efficient power grid. GE launched a \$200m collaborative project and ‘crowd sourced’ ideas to invest in the most popular and efficient ideas. More than 3,000 ideas were submitted on grid modernization and effective utilization of energy resources on the online platform where site visitors could read and vote for the idea. The top 5 ideas were further evaluated by internal engineers in terms of their feasibility and incorporated into the product innovation program¹.

Figure 6: Impact of Digital along the Manufacturing Value Chain



Source: Capgemini Consulting analysis

Figure 7: Business drivers, sub-processes and digital tools in Product Design



Source: Capgemini Consulting analysis

Similarly, applying the concept of crowd-sourcing, Boeing implemented a virtual platform for collaborative aircraft design. It harnessed the collective expertise of engineers from around 100 companies to come together and collaborate through both online and offline meetings during the design process, to create the 787 Dreamliner which was more cost and fuel efficient².

“*GE’s crowdsourcing project on grid modernization and effective utilization of energy resources received over 3,000 ideas*”

Manufacturers are under pressure to reduce time to market and optimize products to higher levels of performance and reliability. Organizations can now use digital technologies such as **virtual prototyping and testing through engineering simulation software**. Such solutions that help to predict performance prior to constructing physical prototyping enable manufacturers to avoid the risks and challenges associated with building real prototypes. Other **virtual validation tools** that can be used are finite element methods, flow analysis and variance analysis tools to simulate physical behaviors and validate digital mock-ups³.

For instance, Samsung utilized a virtual prototyping platform to build a new hybrid hard drive system which resulted in improving design performance by more than 50%⁴.

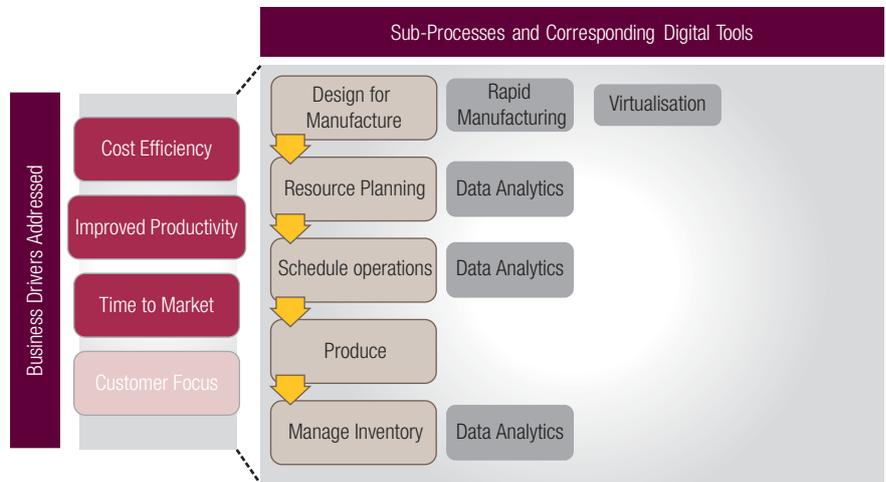
Digital tools also allow for more efficient approach to capturing, sharing and developing knowledge. Integrated knowledge management systems allow manufacturers to build customer-tailored documentation, user guides and technical specifications. Social technologies such as internal social networks, wikis and micro-blogs can also be used as an aid to enhance communication within the organization.

Digitizing the factory shop-floor

Digital tools such as factory virtualization, knowledge enriched planning processes and integrated feedback loops with the physical shop-floor together enable the creation of the foundation of a new digital factory⁵ that can be agile, more efficient and adapts to business requirements easily (see Figure 8).

Digital factory models enable the right mapping of manufacturing processes with the required shop-floor resources. Digital planning encompasses factory knowledge generated from all over the globe using collaborative manufacturing process planning and computer-aided

Figure 8: Business drivers, sub-processes and digital tools in Manufacturing

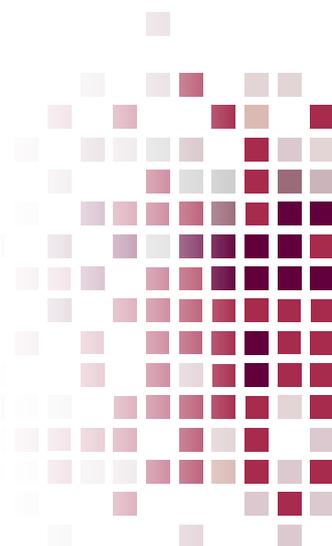


Source: Capgemini Consulting analysis

manufacturing tools. This information can be visualized as a digital factory that is accessible throughout the entire value chain. This helps in ensuring worker operations and logistics flows are optimally harmonized before the product hits the shop-floor. This **allows manufacturers to cut engineering and manufacturing costs** while staying agile.

For instance, aircraft manufacturer Bombardier Aerospace wanted to fast track its manufacturing process and reduce downstream errors. The company created digital models of factories and evaluated designs and operating scenarios before committing to construction and equipment expenditures. The digital models were developed by means of 3D visualization to evaluate the best way to get parts to workstations, determine what production rate could be achieved with various resources, and ascertain what manpower was needed at what stations. The simulations made it possible to reduce the size of the factory by 50% compared to previous standards, resulting in significant cost savings. Using the virtual model, engineers also improved the productivity of the factory by identifying potential bottlenecks and downstream errors, and subsequently redesigning the factory to eliminate them⁶.

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Through digital 3D models Bombardier was able to reduce the size of the factory by 50% compared to previous standards
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Digital analytics helps manufacturers to **reduce working capital costs** through the use of centralized data sources such as virtual factory. A central resource management database also provides insights into the available and installed manufacturing means while **predictive maintenance** reduces machine down-time.

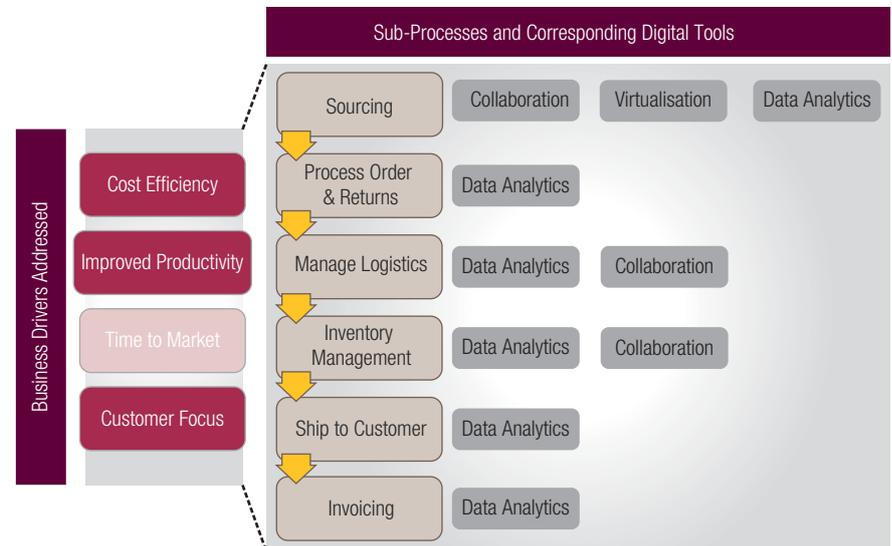
Digital tools also enable manufacturers to have a tight integration of their virtual shop-floors and various planning departments optimizing material flows. Optimized manufacturing operations are transferred to the actual factory through **integrated manufacturing execution systems and ERP systems** with continuous feedback to improve shop-floor operations. Besides the virtual factories, shop-floor resources and transportation means across major parts of the supply chain can communicate with each other and balance themselves through the Internet of things⁷.

Manufacturers can also **minimize time-to-market and manufacturing lead time** by integrating and automating their physical factories. This enables easy implementation of optimized material flows within the virtual factory on to the shop-floor. It also helps in integrating new products into existing manufacturing lines in a fraction of time using **virtual commissioning**.

Virtual factories enable manufacturers to **minimize their inventory costs** by optimizing and harmonizing their manufacturing processes and supply chains. Deployment of technologies such as RFID and advanced warehouse management systems can help organizations **use existing warehouses more efficiently**.

For instance, Wolverine Advanced Materials, a global supplier of vibration damping and sealing materials implemented SaaS technology that enabled the firm to flag and trace all warehouse inventories. All inventory data was integrated with sales, shipping, accounts receivable and planning units allowing it to track inventory with high accuracy and plan for operations more effectively⁸.

Figure 9: Business drivers, sub-processes and digital tools in Supply Chain Management



Source: Capgemini Consulting analysis

Globalizing through digital supply chain management

Deployment of digital tools and technologies for efficient supply chain management enables manufacturers to dynamically adjust their capabilities to market requirements thereby enabling them access to global markets. Key areas that digital tools can help in supply chain management include the virtualization of the supply chain, end-to-end processes for material and value flows, online parts and order tracking, supplier collaboration platforms and real-time supply chain analytics (see Figure 9).

A move to digital supply chains brings with it the immediate benefit of having the ability to **dynamically integrate external suppliers** and even outsource entire functions of the value chain. The entire supply chain, in such cases, acts as one integrated enterprise with continuous multi-directional information flows. Manufacturers can also **trace product quality in real-time** and spot deficiencies thereby reducing returns using advanced supply chain analytics and RFID⁹ technology.

“*Virtual factories enable manufacturers to optimize and harmonize their manufacturing processes and supply chains.*”

An organization that has taken several steps in this direction is ABB. As a part of its initiative to improve business performance, ABB wanted to bring about alignment, adaptability and agility in its supply chain. The company also wanted to increase visibility into its external spending. It implemented eSMART, a collaboration application as an initiative to have greater insights into spending and cost savings. This improved spend transparency to 90%. The improved analysis and forecasting capability also led to increased productivity¹⁰.

Similarly, Caterpillar improved their supply chain visibility through the effective use of a **SaaS solution**¹¹. The company has over 170 production sites and relies on more than 1,000 suppliers shipping components and finished products to other sites or customers. However, the company's data was present in over 100 different IT systems (internal and external). In order to improve visibility, eight milestones were defined for every shipment and tracked in real-time via a **Cloud Supply Chain Visibility solution**. This enabled every supply chain member to enter data via a web interface. Benefits included, among others, an increase in visibility from 0% to 65% of worldwide container movements in seven months. This improved the velocity in the supply chain, resulting in faster reaction to disruptions and shorter order-to-cash cycles¹².

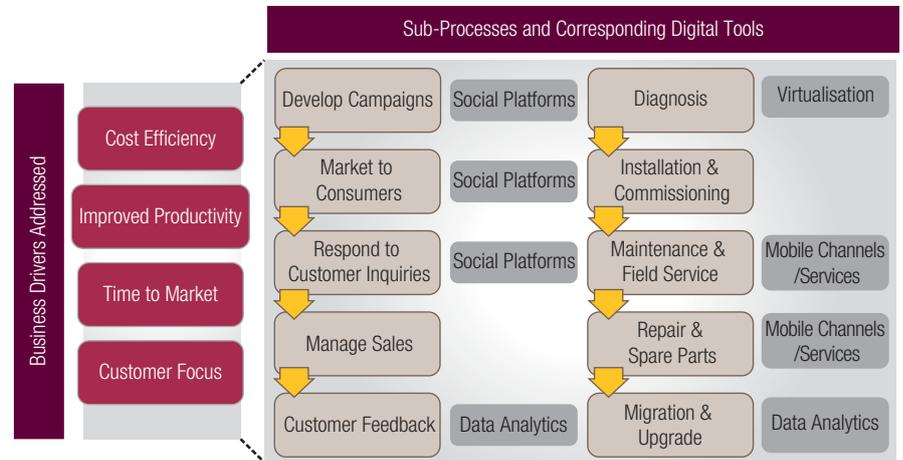
Manufacturers can also use digitization to create highly **efficient and transparent logistics processes**.

For instance, Boeing, in partnership with Fujitsu offers a comprehensive automated identification technology (AIT) packages on commercial aircrafts for any manufacturer to track and monitor avionics and other critical parts through RFID tags¹³.

Digital technologies also enable manufacturers to consider detailed customer requirements such as delivery times, volumes and provision containers, and configure their **virtual supply chain** accordingly. Using further services such as **web-based order tracking**, customers can be empowered to track the efficiency and performance of supply and adjust their internal processes accordingly.

Manufacturers can also implement **integrated performance-based payment** processes within supply chains. In such systems, suppliers are paid based on their performance in terms of time and quality allowing new services and payment options to be offered to customers. Advanced concepts, such as pay for operation and consumed services according to defined service level agreements, allow manufacturers to provide comprehensive customer-specific solutions.

Figure 10: Business drivers, sub-processes and digital tools in Marketing, Sales & Service



Source: Capgemini Consulting analysis

Digitally customizing marketing, sales and services

Online marketing, social media and e-commerce allow new possibilities for manufacturers to connect and address global customers and offer localized products and services (see Figure 10).

For manufacturers that have significant presence in direct consumer channels (for example, automotive and parts of high tech), **virtual digital campaigns** help them address and customize their message to global consumers at effective cost by using **targeted marketing**.

For instance, BMW integrated its offline and online campaigns using eBridge - a digital marketing tool which resulted in an increase in user rate and conversion rate to sales. Similarly, Caterpillar also successfully implemented social media tools to facilitate interaction with consumers to understand their needs and requirements¹⁴.

Digital channels can play a significant role in creating a positive customer experience. Customers can be informed about product benefits through sophisticated **online sales platforms** as well as a digital sales force. Field sales teams can use advanced mobile devices such as tablets to demonstrate complex products. Digital channels also help

manufacturers **engage with customers** to gain insights from real usage that will help them refine their products. Organizations can manage detailed information about their customers and their field service staff through mobile devices which can be retrieved on-the-go.

Marketing insights can also help manufacturing companies build long-term profitable customer relationships, thereby generating new revenue streams.

For instance, a leading premium car manufacturer applied connected car analytics, turning crude data into customer insight based on vehicle usage (driving style, routes, preferences, family and lifestyle, etc.). Based on the digitized customer profile, the car manufacturer boosted its sales and marketing performance and explored new business models and partnerships¹⁵.

“*Caterpillar was able to drive visibility from 0% to 65% through the use of a cloud supply chain visibility solution*”

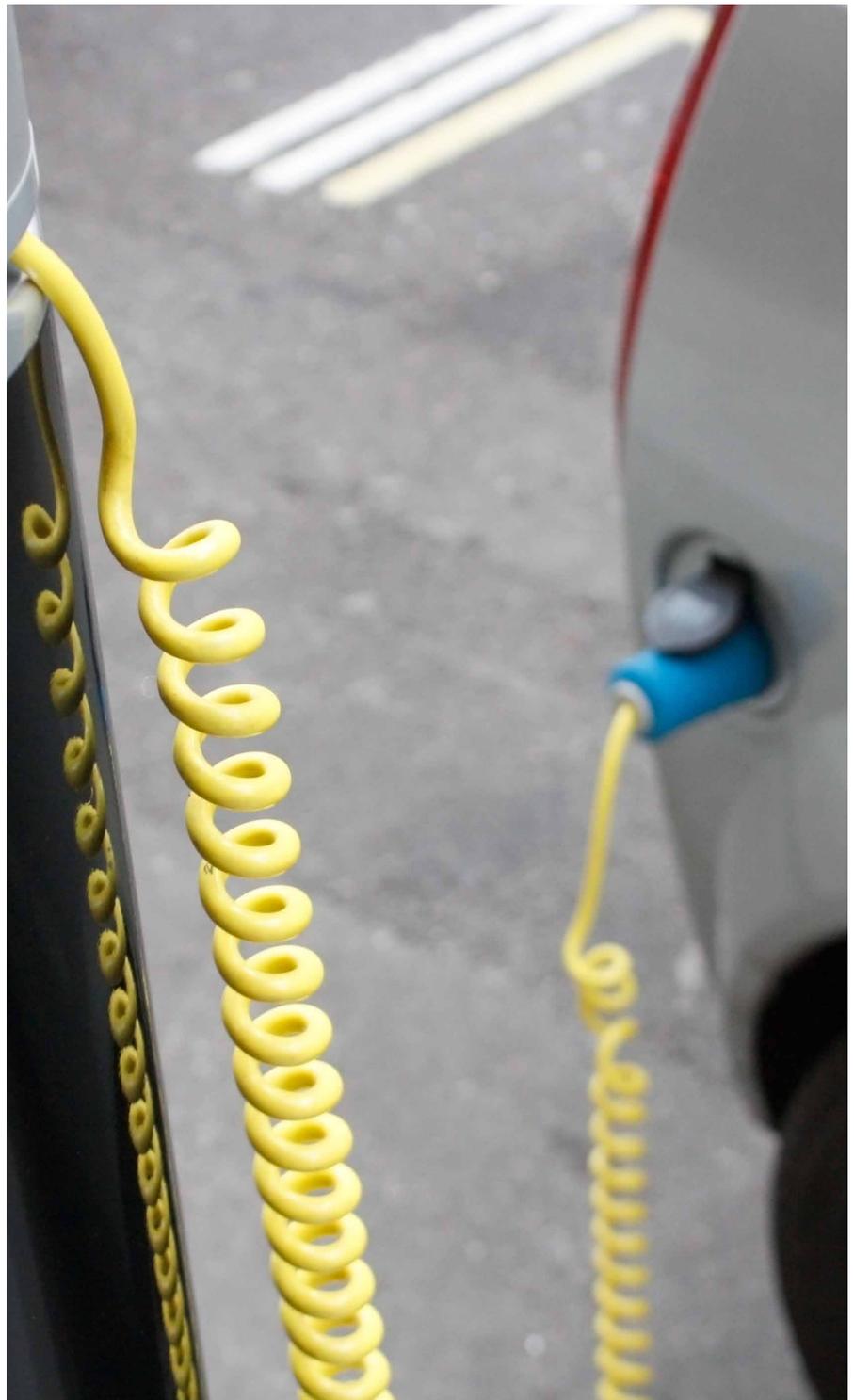
Digital tools can also aid in the improvement of products and services of manufacturing companies.

For instance, Texas Instruments was able to drive improvement by analyzing digital consumer conversations through an ongoing “listening” function. The data was further captured and analyzed for product and service improvements. Through usage of enterprise 2.0 tools, the company effectively surrounded its customers with multiple touch points, positioning itself as an innovator. Faster and more effective communication with its customers enhanced the brand image and customer satisfaction index significantly¹⁶.

Effective use of digital tools can help manufacturing companies realize a high product value-add and lower costs of ownership through an **integrated monitoring of product performance and predictive maintenance**. Integrated product sensors feed performance data back and enable the manufacturer to predict issues even before they occur. Maintenance activities are planned accordingly for the entire customer base. Furthermore, this information can be used in product development to eliminate errors and drive new product innovations.

For instance, take the case of an e-mobility company, Ubitricity. An ordinary charging station for electric cars costs several thousand Euros, and a country such as Germany will need about 3 million of them to operate area-wide until 2020. Ubitricity uses common electric outlets and puts the metering into the car, also called “mobile metering”. If a car is plugged in, the electric outlet communicates with the car and an identification process starts. Via mobile communications, identification and charging data are automatically pushed to the energy provider. Drivers receive a detailed listing of their charge, similar to a detailed cell phone bill. At the same time, customers receive a single and comprehensive invoice, increasing customer satisfaction. Moreover the grid operator can potentially save significant investments on every single charging station¹⁷.

In the next section we discuss the key benefits and impact that digital tools and technologies can have on the operating model of manufacturing companies.



Digitally Transforming the Operating Model



The impact of digital tools and technologies can not only be felt across the value chain, it can indeed have significant impacts on the operating model. We identified five major areas of global Manufacturers' operating models which can be transformed towards higher agility and corporate performance.

Digitally exploiting centralization and de-centralization opportunities to enable manufacturers to find the right degree of specialization in local operations

Many manufacturing companies have been strongly growing on a global scale by entering new markets (especially in the emerging markets) and conducting acquisitions to complement their geographic, product and technology coverage. New digital capabilities enable them to own and orchestrate a significant amount of local divisions and businesses. Thus, digital manufacturing enables manufacturers to find the right degree of specialization in local operations, while centralizing general functions in an appropriate manner. Technology-enabled end-to-end process automation and harmonization as well as real-time analytics help to achieve a holistic performance transparency across the processes, which in turn form the basis for leveraging synergies and efficiency gains. Best practices show that digital leaders nimbly adapt to needs of market proximity and localization, where decentralized operations can be easily configured focusing more on domestic markets.

Digital technologies enable an integrated profit and cost allocation to leverage synergies across distributed divisions, while strengthening local presence and entrepreneurial spirit

Global manufacturing companies often work with historically grown, decentralized operating models featuring numerous local units and manufacturing sites. Instead of managing these as individual profit centers, the profit and cost allocation logic as well as the target systems can be optimized by using digital technologies to leverage synergies across

locations and divisions, while keeping and strengthening local presence and entrepreneurial spirit in these units. At leading manufacturers, supply networks and factories are managed as cost centers, whereas business units are acting as profit centers bearing the commercial business responsibility.

Digitally managing global supply networks to enable capacity optimization and load balancing

Manufacturing companies can use integrated enterprise resource planning and advanced scheduling tools to manage global manufacturing sites and subcontractors under one responsibility. Thus, local demand forecasts and sales orders can be globally balanced and allocated to local manufacturing sites in an optimized, transparent manner.

Digitally integrated sales and services divisions provide comprehensive but localized business solutions

Cross-divisional account managers as well as digitally integrated sales & service operations can be established by leading manufacturers to leverage cross-selling opportunities, focus on customer solutions and strengthen geographical presence. Therewith, innovative business models with comprehensive business solutions can be realized through the right level of integration and coordination of formerly isolated business divisions.

Leveraging synergies through digitally enabled shared support service centers

Digital technologies can help manufacturing companies to centralize business planning, order management, technology management, sourcing, finance and human resources with the help of increased automation and integration into the value chain as well as centrally provided expert knowledge. For example, comprehensive databases with product compliance rules for various markets can be maintained centrally and utilized within local development and sales operations. Companies should pay special attention to central IT services that are crucial for a globally homogeneous and integrated IT landscape and business processes.

For instance, a leading crane manufacturer strongly grew organically and through acquisitions within its product and services business over the years. Through a new enterprise application landscape and new digital technologies, more than 400 global locations in more than 30 countries could be integrated and transformed into one global operating model that enabled the company to leverage global synergies and efficiencies while meeting local business requirements. A global supply network, regional cross-selling of products and services, a central project and order management, global solution lines as well as an optimized profit and cost center allocation was implemented based on a centralized and standardized ERP backbone combined with web and SaaS based digital technologies for customer and key supplier interactions. Therewith on-time delivery, revenues, inventory costs, non-conformance costs and asset utilization could be improved significantly throughout the company¹⁸.

In many cases, manufacturing companies have not fully leveraged the available synergy and efficiency opportunities within their global business and operating models. Changing historically grown operating models or even entire business models means a substantial intervention in terms of organizational structures and business rules, which could cause resistance from major stakeholders. Digital transformation multiplies these challenges manifold given the wide-ranging impact that they can have across the length and breadth of the organization. Building digitally integrated and centralized operations as well as a tight collaboration with locally autonomous departments require an extended competency profile of management and employees and a clear cultural shift. Top management commitment and a well-prepared multi-dimensional transformation are key success factors for that change.

In the next concluding section we discuss a methodology that manufacturing companies can leverage to create a digital roadmap to support their business objectives and also provide recommendations on how to prepare for and implement the next wave of digital innovations.

Digital Roadmap: The way forward



Manufacturing companies will need to adopt a systematic approach to address digital opportunities across the manufacturing value chain. We believe that manufacturers should take a four-pronged design-innovate-prioritize-implement approach (see Figure 11).

Envision the digital future for your company

Manufacturers should design the digital agenda with a clear outline of the strategic business objectives to be achieved. Short and long term objectives need to be explicitly defined and committed to by all functions (top-down) prior to commencing the project.

We believe the transition to becoming a leader in using digital in manufacturing will require organizations to focus not only on bottom-line improvements, but also on top-line opportunities such as increased customer focus and reduced time to market.

Select innovations that can provide business value now

Once an agenda has been firmed up, manufacturers should gain a good understanding of the latest digital applications in the market across the manufacturing value chain. This is the starting point of identifying potential innovations that can be applied.

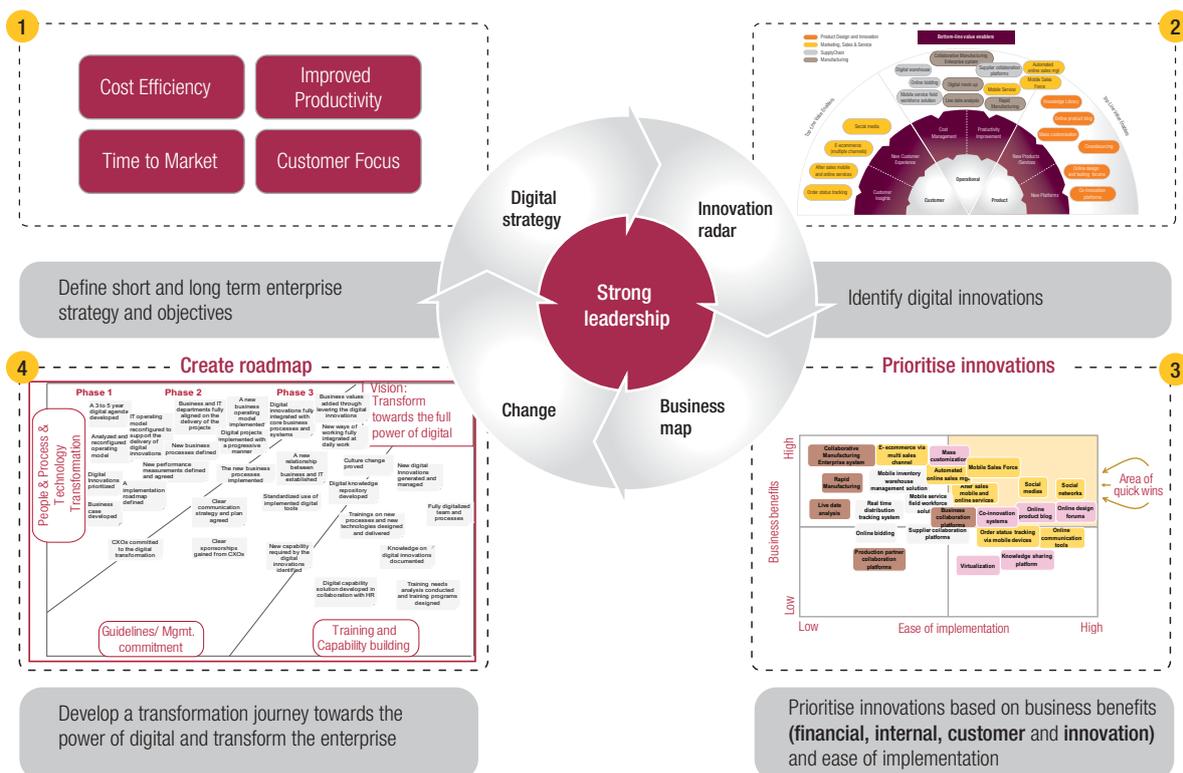
Prioritize the digital transformation initiatives

The next step after identifying digital innovations is to prioritize the initiatives based on the perceived business benefits and ease of implementation. Complexity of the implementation will depend on the required level of integration with the existing core business processes and systems. A well made prioritization matrix helps in identifying quick wins that jump-start the firm on the path towards digital transformation.

Create the digital roadmap

Once the digital innovations are prioritized and selected, a digital roadmap has to be created that should contain phase-wise transformation details. The digital roadmap helps to make the transformation journey tangible and is ideally built on a common action by management, business representatives from the different functions and IT. The digital transformation journey can be successful only if all parties work with a uniform vision.

Figure 11: Design of a digital roadmap



Source: Capgemini Consulting analysis

The continuous implementation of the roadmap towards leveraging the benefits of digital has various challenges. One of the biggest challenges manufacturing companies will face is to change the well-defined understanding of roles and responsibilities, where IT is mostly seen as a service provider. In the course of Digital Transformation, today's borders become blurred as IT involvement with manufacturer core competencies increases. The challenge is to transform the current mindset and accept IT as a business partner across all areas of the manufacturing value circle.

In summary, it is crucial to not see Digital Transformation as a quick-fix solution within rigid manufacturing processes and resources, but to recognize it as a long term commitment to changing the people, processes and culture of an organization in order to fully leverage the benefits of new digital opportunities.

“
Digital Transformation is not a quick-fix solution within rigid manufacturing processes and resources, but a long-term commitment and imperative
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