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A Manufacturer's Guide to Environmental Sustainability and Digital Transformation

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451 Research

S&P Global Market Intelligence

Introduction

A variety of pressures — market, social, competitive, customer and regulatory — are pushing sustainability toward the top of manufacturing executives' strategic priorities, joining digital transformation. According to 451 Research survey data, about 60% of manufacturers are in the execution stage of digital transformation[1] and 35% have a formal ESG program in place or are actively planning one[2].

Traditionally, manufacturers have operated digital transformation and environmental sustainability initiatives in separate workflows and siloed environments. To respond to expanding outside pressures and achieve environmental sustainability goals — such as reducing carbon footprint across operations, setting target dates for net-zero emissions and facilitating the adoption of renewables — manufacturers must turn to their digital transformation programs. Sustainability programs can identify and prioritize the metrics that will drive the greatest impact, while digital transformation can provide the innovative technologies to unlock them.

While combining these programs has great promise, as with any major enterprise strategic initiative, doing so would bring unforeseen complexities. Digital transformation has well-documented challenges: identifying business drivers and key performance indicators (KPIs), formalizing plans, implementing technology into processes and gaining key stakeholder buy-in. Sustainable manufacturing initiatives have similar challenges that are amplified by a growing sense of urgency from market and regulatory demands.

This guide to digital transformation and environmental sustainability aims to assist manufacturers that are looking to make strides with insights that are applicable regardless of digital maturity.

Key Findings

- Most manufacturers (60%) are at the execution stage of their digital transformation, meaning most have a formal technology-driven program or project operating in a real-world production environment.
- More than half (53%) of manufacturers have a formal target to reduce their environmental impact, which is comparably higher than other industries (41%).
- Three critical ESG business drivers for manufacturing are: ensuring compliance with environmental regulations and other laws (61%, compared with 44% in other industries), improving operational efficiency, and innovating to meet rising customer demands.

1. 451 Research's Voice of the Enterprise: Internet of Things, Lightweight IoT 2022
2. 451 Research's Voice of the Customer: Macroeconomic Outlook, Business Trends, ESG 2022

The Take

Manufacturers already recognize the necessity of digital transformation and are realizing the need for sustainability as they face tremendous outside pressures to reduce their environmental impact. Unsurprisingly, the starting place for many manufacturers is to ensure they are compliant with current regulatory frameworks, which are table stakes to reduce possible business risk from government mandates. This could include measurement and reporting of direct operational or energy/power emissions (Scopes 1 and 2) or increasingly important supply chain emissions (Scope 3).

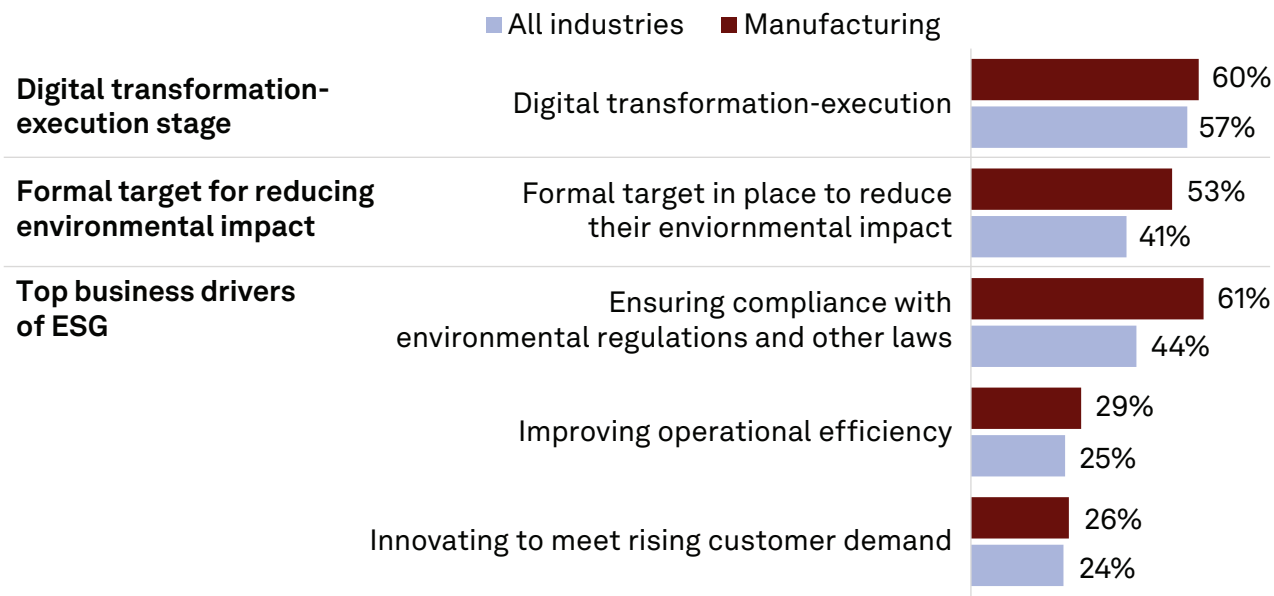
Improving profit margins and reducing costs will always be important manufacturing considerations, which is the premise for improving operational efficiencies as a key sustainability business driver. Manufacturers will increasingly pursue production and process optimization not only to become more operationally efficient, but also to reduce their carbon footprint. Finally, customers are demanding more innovative and sustainable products from manufacturers. This is driving rapid adoption of sustainable manufacturing as a precursor to product differentiation to make gains in new avenues of growth and defend against customer churn from increasing environmental concerns.

Top Digital Transformation Use Cases for Environmental Sustainability in Manufacturing

It is important for manufacturers to understand the current state of sustainability as a comparable benchmark for programs. A few key manufacturing sustainability data points are shown in Figure 1.

There are dozens of digital transformation use cases emerging to serve the growing need for more sustainable manufacturing. With the impact of these use cases spanning the product life cycle, we'll focus on a few prominent examples in the manufacturing value chain where the impact is becoming noticeable.

Figure 1: What's driving sustainability efforts for manufacturing?



Q. Which of the following best describes the status of your organization's digital transformation strategy?
Base: All industries (n=700), manufacturing (n=99).
Source: 451 Research's Voice of the Enterprise: Internet of Things, Lightweight IoT 2022.
Q. Which of the following best describes your organization's approach to reducing environmental impact?
Base: All industries (n=535), manufacturing (n= 68).
Source: 451 Research's Voice of the Enterprise Digital Pulse Environmental Impact 2022.
Q. What are your organization's main business drivers for creating an ESG commitment or program?
Base: All Industries (n=234), manufacturing (n=31).
Source: 451 Research's Voice of the Customer, Macroeconomic Outlook, Business Trends, ESG 2022.

Design for Sustainability in Engineering

Sustainability decisions usually begin for manufacturers in the product decision phase where engineering departments are already challenged with creating differentiated and better-performing products with lower costs while maintaining quality. Adding sustainability into this already complex product design equation triggers several other variables to consider, including sourcing of materials that are less harmful to the environment and parts from reputable, ethical and local suppliers.

Manufacturers are also procuring and producing higher-performing parts that weigh less and use fewer materials; this emerging design process known as light-weighting can have an impact on engineering's material costs and the end product's operations, including reducing its carbon emissions and energy consumption. Topology optimization and generative design leverage AI to expedite light-weighting by prioritizing designs that use only essential materials and parts that meet or exceed performance requirements. Building prototypes is a necessary but costly and wasteful design process; real-time simulation creates a virtual environment to run many of these physical tests without the high overhead costs.

As these more environmentally friendly designs are deemed critical, the desire to leverage these innovative tools and technologies within a streamlined product development process grows. Computer-aided design (CAD) is needed to create these increasingly complex and "greener" products infused with more sustainable materials and innovative structures formed by generative design. Product life cycle management (PLM) helps enforce the product's integrity and maintain an authoritative source of truth for sustainability requirements and traceability to accurately measure environmental impact across the manufacturing value chain.

Design for sustainability examples: Consider a global manufacturer of truck engines that weigh upwards of 1,000 pounds and power tractor trailers. If a product designer used CAD embedded with generative design to reduce the engine's weight (light-weighting) by even a few percentage points across a fleet of thousands of tractor trailers, it could drastically improve their load capacity, fuel efficiency and impact on the road infrastructure while reducing costs from using less material (e.g., metal) to build the engine.

In a more long-term sustainability project, the product designer could be developing the next-generation battery for electric tractor trailers. This would require managing an entirely new and complex product development process to generate the sustainable efficiencies an electric vehicle can unlock. A manufacturer can simultaneously execute on these two examples to make design adjustments that reduce the weight of the engine for sustainability gains in the short term while pursuing more long-term sustainability with electrification.

Sustainable Manufacturing Production in Operations

Manufacturers with global facility footprints will eventually have to undertake some form of carbon or emissions reporting. This could include Scope 1 or "direct" emissions that are a result of on-site operations including production lines and machinery, and Scope 2 emissions or "indirect" from the output of used energy (electricity, heating/cooling, steam, etc.). While these and other regulatory hurdles have historically been lower-priority items limited to compliance checklists, they have quickly risen to the top of manufacturing imperatives to reduce their carbon footprints as well as operational costs.

Operating more efficiently in manufacturing production facilities can be a win-win for the environment and profit margins. There is a vast array of technologies now part of manufacturing operations through digital transformation and Industry 4.0 initiatives that can drive cost efficiencies and more sustainable manufacturing.

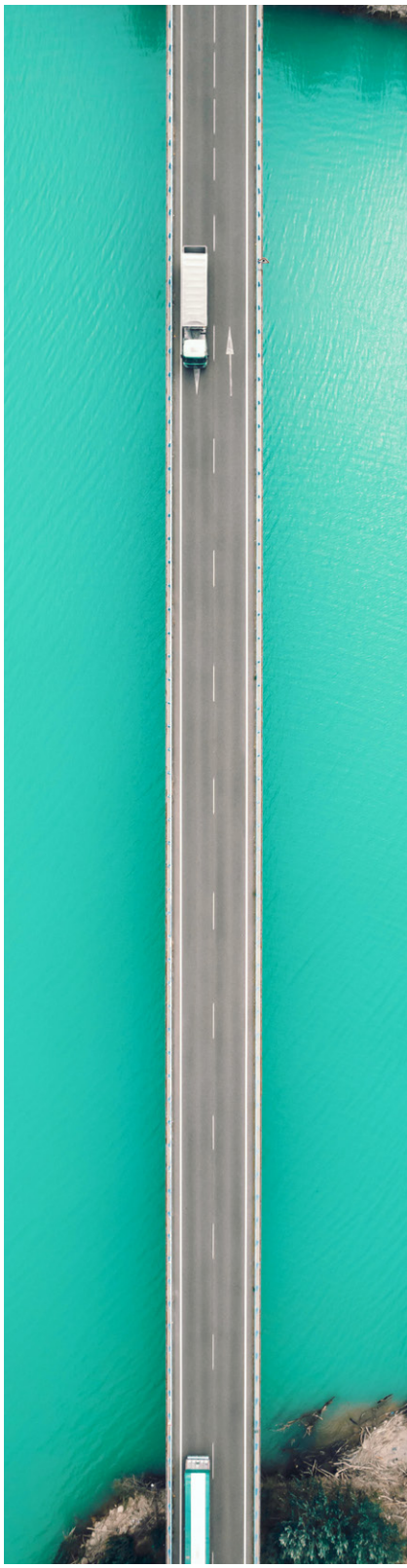
Reducing energy consumption is a top sustainability use case where manufacturers are leveraging industrial IoT (IIoT) to monitor, manage and analyze power usage to identify energy-intensive processes and take action. According to recent survey data[3], 83% of manufacturers say the deployment of IoT technology has a slight or significant effect on their organization's initiative to limit its environmental impact, including reducing carbon footprint. Digital twins and AI/machine learning tools are identifying bottlenecks in assembly lines and entire facilities to better match production capacity with demand.

Technologies that increase the productivity of factory workers/operators can have a derivative impact on sustainability KPIs by enabling error and waste reductions. These include digital work instructions facilitated by up-to-date product information from PLM systems and placed into frontline workers' field of view via augmented reality (AR). Enforcing consistent creation of high-quality and complex products while minimizing waste is an ongoing challenge but a possible beneficiary of more sustainable manufacturing.

Sustainable manufacturing production example: On a production line for a truck engine, there could be hundreds of machines consuming significant amounts of power and contributing substantial amounts of waste. These machines and the workers operating them could have inefficiencies that generate production bottlenecks and unnecessary energy consumption. IIoT, AI and other technologies provide real-time visibility and predictive insights into this environment. This helps manufacturers identify and act on inefficient manufacturing processes, enabling more sustainable manufacturing production.

3. 451 Research's Voice of the Enterprise: Internet of Things, Lightweight IoT 2022

Efficient Product Operations in Service



The traditional model of manufacturers creating a product and having minimal insight once the product leaves its factory has ended for a few reasons, all of which have sustainability implications. First, customer feedback and usage data has never been more necessary for product differentiation, and it has never more accessible as now via digital technologies. Product telemetry from real-world operations is feeding engineers with insights (known as closed-loop engineering) that can improve product performance and utilization, which prolong the product's useful life and efficiencies. The engineering team creating more durable and longer-lasting products reduces the need for customers to procure replacement parts and any shipping-related emissions.

Second, the opportunities to deliver consumption-based and post-sale service models are revenue drivers. Tightened product margins have pushed manufacturers toward service innovation and leveraging "products as a service" where service-level agreements require the enforcement of a product's uptime in customers' operations. However, these operations can be significant cost centers that are detrimental to sustainability metrics. Maintaining this uptime can require costly and emission-intensive truck rolls — generating significant fuel inefficiencies — with technicians traveling to geographically dispersed customer locations. Leveraging IIoT for remote monitoring and predictive service lessens this costly dispatch by negating the need for technicians to be on-site for routine maintenance activities. Leveraging over-the-air remote software updates when there are equipment malfunctions, or the equipment needs to be turned off, further reduces power consumption. There will be situations in which technicians are necessary; providing them with accurate and up-to-date service instructions improves first-time fix rates and reduces mean time to repair and customer downtime, improving efficiency and reducing the environmental impact.

Finally, manufacturers are increasingly assuming responsibility for Scope 3 emissions, which, according to S&P Global Trucost, can account for 84% of greenhouse gas emissions in some companies[4] and includes manufacturers' products' operation and impact on the environment. Even further downstream, manufacturers are now responsible for end-of-life decommissioning, recycling of materials and increasingly restocking and remanufacturing their deteriorated products. Customers will increasingly demand that manufacturers deliver more environmentally friendly products, disassembly instructions and sustainability programs for responsible decommissioning of products.

4. https://www.greenbiz.com/article/state-net-zero-now

In a recent survey, 85% of manufacturers said their customers believe that manufacturers' progress toward their stated environmental objectives is somewhat or very important[5]. These higher-than-industry-average (76%) responses are further testament that customers in both B2B and B2C scenarios are demanding sustainability improvements from their product manufacturers.

Efficient product operations example: A truck engine manufacturer could move away from traditional "break-fix" maintenance models by leveraging IIoT engine operational data for predictive diagnostics to analyze behaviors that could lead to costly, resource-intensive and possibly even deadly downtime if the vehicle were to crash. In situations where the engine breaks down and requires replacement, service life cycle management software can quickly triage a suitable replacement engine to be delivered efficiently from a dealership with inventory. A service technician could leverage AR-enabled digital work instructions to quickly install the engine based on PLM feeding the specific customer engine configuration. Engine performance data could also provide engineering departments with design insights for future product iterations, further improving fuel efficiencies. Across all these more efficient product operations activities, systems that can accurately capture and calculate the engine's environmental footprint over its usable life will be increasingly critical for the requirements of carbon emission compliance measurement and proving tangible impact on sustainability metrics.

5. 451 Research's Voice of the Enterprise: Digital Pulse, Environmental Impact 2022

Conclusion

When digital transformation and enabling technologies are tightly aligned to sustainability initiatives, manufacturers can view sustainability as an opportunity to innovate and differentiate rather than as a risk or compliance obstacle they must hurdle. In the near future, there will be very few decisions across the manufacturing value chain that sustainability will not impact. Those that are ahead in embedding a sustainability-first mindset into their processes will be the "lighthouse" manufacturers of the future.

About the author

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David Immerman is a Consulting Analyst for the TMT Consulting team based in Boston. Prior to joining S&P Global Market Intelligence, David ran competitive intelligence for a supply chain risk management software startup. He spent nearly four years at an industrial software vendor providing thought leadership and market research on technologies and trends in manufacturing. Previously, David was an industry analyst in 451 Research's Internet of Things channel for three years, primarily covering the smart transportation and automotive technology markets. He holds a bachelor's degree in Business Administration from Marist College.

About S&P Global Market Intelligence

S&P Global Market Intelligence's Technology, Media and Telecommunications (TMT) Research provides essential insight into the pace and extent of digital transformation across the global TMT landscape. Through the 451 Research and Kagan products, TMT Research offers differentiated insight and data on adoption, innovation and disruption across the telecom, media and technology markets, backed by a global team of industry experts, and delivered via a range of syndicated research, advisory and go-to-market services, and live events.

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