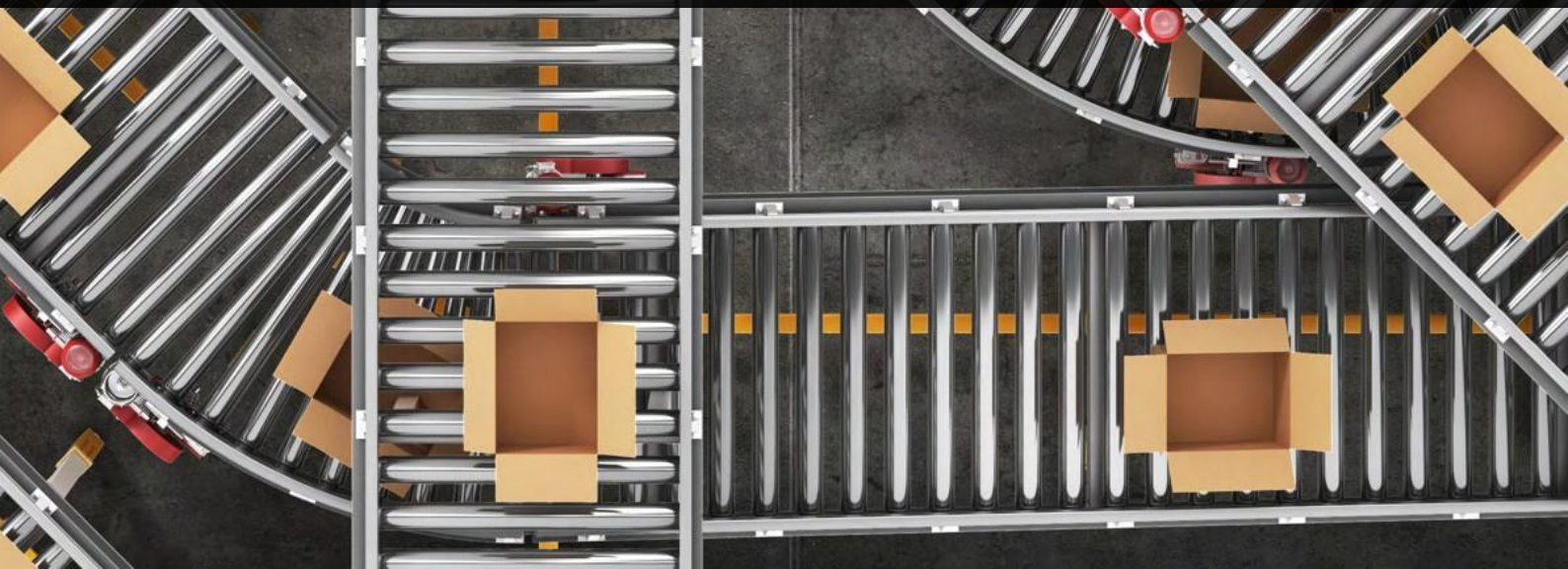


Digital Traceability: A Framework for More Sustainable and Resilient Value Chains

WHITE PAPER
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Foreword



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Leadership teams in every industry face a strategic imperative to create more sustainable value chains. Long gone are the days of slow and incremental improvements. To compete, companies must adapt to rapidly changing consumer preferences and stakeholder demands for more sustainable products and circular value chains.

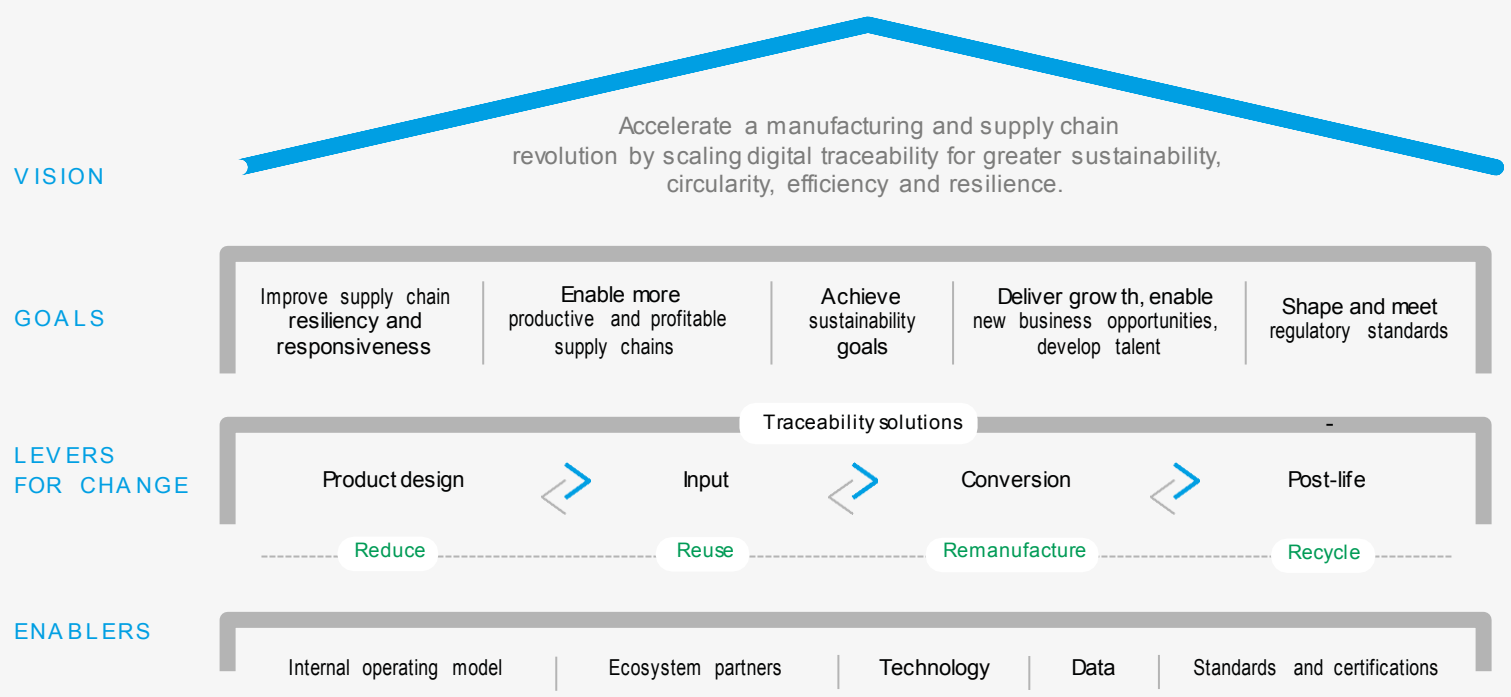
Most organizations have set ambitious sustainability targets, vowing to reuse, remanufacture, or recycle their products to minimize their impact on the environment. But the hard part lies ahead. Companies now need to translate those goals into specific, tangible actions to prove to a multitude of stakeholders that they have delivered on their commitments.

Traceability across the entire value chain is the key to success. Traceability technologies provide management teams with a treasure trove of digital information about the upstream suppliers providing raw materials, the downstream partners adding value, customers who purchase the product, and all the processes along the way. Improved visibility on inputs and processes gives executives the means to achieve their sustainability objectives and provide vital data for provenance and sustainability certifications.

But traceability is more than a tool to enable sustainability. Leading companies rely on traceability to achieve a broad set of interrelated objectives, including supply chain resilience, efficiency, visibility, security, regulatory compliance, reliability and additional growth through new business models. Leadership teams that tap traceability to realize a broad set of objectives unleash a multiplier effect. At the same time, they accelerate the shift towards more circular production processes (recycle, reuse, remanufacture). These first movers will have a stronger, more integrated impact on value chain design than their competitors.

The rewards of getting it right are substantial. Companies that build robust traceability will be able to meet their sustainability targets, stakeholder demands and new regulatory requirements. They also will be able to deliver the right product to the right place at the right time and with the right level of customization and speed – all at a competitive cost. Finally, these leaders will be more resilient in the face of supply-and-demand shocks as traceability helps companies predict potential threats and adapt faster to disruption. All those advantages will help deliver stronger growth and profitability and enable new business models (see Figure 1).

FIGURE 1 | Traceability framework



Source: World Economic Forum; Bain & Company



Executive summary

Leadership teams are facing a pivotal shift. To compete effectively, companies need full visibility throughout their value chains. This paper presents a framework for understanding how traceability accelerates progress towards more sustainable outcomes and, in parallel, delivers better business results and improved competitiveness. It encompasses company issues and broader community issues that are critical in enabling traceability. It also details the four steps critical to a successful traceability effort: connecting traceability to sustainability and business objectives; building a collaboration ecosystem across your value chain; deploying key enablers such as data and technology; and taking a rapid test-and-learn approach to get started.

In some ways, the traceability journey is analogous to a digital transformation. The multitude of technology options and application areas is overwhelming. It is relatively easy to set up a simple pilot but scaling it and amplifying the benefits across different application areas is challenging. Traceability adds a new element of complexity – the need to collaborate closely with a vast ecosystem of value-chain partners.

Successful companies are taking the lead and engaging partners in the value chain to help achieve broader sustainability goals while building solutions tailored to their own strategic objectives. They start by assessing their industry sector dynamics, regulatory requirements, customer expectations, stakeholder demands, competitive dynamics and potential value chain shocks. Each of these considerations informs the company's goals and potential trade-offs.

An important first step is preparing the organization for the journey. Traceability requires cross-functional coordination across the entire value chain, often in ways that challenge traditional operating models. Traceability also involves collaboration between companies that may not have worked together in the past. Partners must identify how to collect, govern, protect and share relevant information across the ecosystem.

Choosing the underlying technology to share and host the data brings another set of challenges. Each company needs to ensure data security and privacy. In addition, the technology must scale across partnerships and application areas, connect to existing systems, and interoperate with other traceability systems inside and outside of the company. Those demands require significant investments and partners will need to determine

how to share the costs and benefits. Most successful traceability efforts start small, with a high-value application. That approach allows companies to set up the right standards for data, technology and collaboration, and ensure value for every participant. A micro-battle approach, with each initiative serving as microcosm of the scale solution, has served many sectors well.

As we have seen in digital transformations, the biggest risk for companies is ending up in a pilot doom loop. Experimentation is easy, but transformation at scale is hard. For complex and cross-functional topics like traceability, it is imperative to determine in advance how to scale each initiative. Successful efforts may start small, but they also start with a detailed scaling plan across application areas, use cases and enablers.

The four sections that follow explore each step of traceability transformation in depth and share best practices from industry trailblazers. Our hope is that this framework helps management teams plot a successful path forward and achieve their sustainability and business-performance goals, while establishing a foundation on which new cross-company and multistakeholder collaborations can emerge.



The case for digital traceability

1.1 A source for sustainability and improved competitiveness

For more than a century, businesses have honed highly efficient, linear supply chains. Raw materials flowed in one direction as they were transformed into a product, used and ultimately discarded in a waste heap. That approach now puts a firm's competitiveness at risk. Investors, consumers and governments are demanding that both products and processes become more sustainable. Companies also face an increasingly volatile business landscape that requires greater value chain resilience to ensure supply. Winning in the coming decade will require a transparent and circular value chain – one that reduces or reuses materials and remanufactures or recycles products – lowering costs and creating less waste.

It is a profound paradigm shift. No company will be able to go it alone. Creating circular value chains will require new alliances and a much deeper degree of company collaboration across an

industry's value chain. It will also require extensive public-private partnerships, a new approach to managing operations and investment in state-of-the-art technology.

Digital traceability enables companies to meet their sustainability objectives and achieve a broader set of business goals, including efficiency, resilience and responsiveness. It allows companies to improve operational excellence and set aspirational new goals. In the future, our expectation is that companies with traceable value chains will outperform those without them.

How does it work? Traceability gives companies the ability to identify strategic value chain opportunities, innovate faster, minimize the impact of internal and external disruptions, and certify sustainable processes and products. They are also able to follow products and goods as they move along



the value chain and glean exact information about the provenance of inputs, supplier-sourcing practices and conversion processes. With that data in hand, companies can make predictions, run scenarios and dynamically optimize operations, and leadership teams can serve customers better, identify unnecessary resource consumption, respond faster to changes in demand and fulfil orders more efficiently.

These combined benefits will translate into higher revenue growth, lower costs, increased market share, better returns on investment, and overall improved stakeholder returns. Traceability leaders will also help shape the standards and regulations in their sector. In the coming decade, they will leap ahead of the competition in realizing their sustainability goals for 2030 and beyond. Firms that do not invest in traceability will underdeliver on their

sustainability ambitions and lag behind in growth and profitability. They also will be more vulnerable to supply chain disruptions and allegations about product safety or provenance. For example, the stranded 400-meter cargo ship that blocked the Suez Canal recently left hundreds of other cargo ships stuck behind it, wreaking havoc on global supply chains. The companies that knew what cargo their ships were carrying were able to quickly reroute shipments to minimize the supply disruption.

Those who lacked visibility were hit hardest, waiting to find out which goods were blocked.

COVID-19, escalating trade tensions and other recent disruptions have demonstrated how critical traceability is to both sustainability and competitiveness. In fact, companies that invest in traceability with a singular focus on sustainability or improving competitiveness will fail to get the highest return on their investment.

Pressure for change

Companies face a growing chorus of demands to make their value chains more sustainable and transparent. Customers purchasing materials or goods within an industrial value chain and consumers who buy the final product want to know what they are buying and how it was made. Interest groups are advocating new sustainability requirements that ensure value chains are ethical, environmentally friendly and reliable. Industries close to end consumers tend to face the greatest pressure to address those concerns.

For example, [67% of consumers](#) want to know the origin of their food and [69% of customers](#) under 40 would pay extra for sustainably sourced electronic products. And B2B companies are also feeling the heat from their customers. A growing number of corporations expect their suppliers to implement traceability protocols for increased quality assurance and logistical intelligence. Similar pressure is likely to increase from investor and employee groups.

At the same time, governments around the world are raising the bar on value chain transparency as consumers, investors and other stakeholders call for a new era of corporate responsibility. Many countries require companies to report value chain data and develop improved systems for product and input tracking. Regulators concerned with quality and safety standards are expanding their focus to include environmental and social responsibility. New European Union rules (e.g., [the European Due Diligence Act](#)) will require firms in all industries to conduct human rights due diligence in their value chains or face severe financial penalties. Canada and other countries are working to expand carbon tax programmes ([e.g., Government of](#)

[Canada, How carbon pricing works](#)) that will require firms to develop greater accounting of their full scope emissions, a task that is impossible without upstream value chain visibility.

Again, the growing risk of economic turmoil and disruption makes a strong case for investing in traceable value chains. The pandemic trade tensions and extreme weather events have challenged firms in virtually every value chain over the past year. Those trials have made it clear to executives that greater visibility and resilience in their supplier networks will help them succeed in tumultuous times.

Finally, traceability can help companies gain competitive advantage, especially those grappling with significant value chain risks, consumer pressure, or low-margin industries. For example, auto manufacturers battling for scarce electric vehicle components can use traceability systems to gather insights from their supplier networks and improve continuity of supply. Another example is the increased investment of apparel firms in downstream visibility to achieve high marks from consumers on established transparency ratings systems such as the Fashion Transparency Index. That recognition helps firms capture more market share in the responsible apparel segment.

Not surprisingly, companies around the globe, and in every sector, are making traceability a priority as part of their operational capabilities. Bain's recent Global State of Traceability survey, a consultation with more than 150 senior supply chain leaders, shows 68% of executives view traceability as "very or extremely important".

Key considerations in getting started

Traceability solutions can be deployed in many ways to bolster sustainability and strategic advantage. The first step, and a vitally important one in defining a traceability strategy, is determining where tracing will generate the greatest value for the company, both today and in the future. Leadership teams that fail to focus their investment risk overwhelming their value chains with complexity. They are also likely

to overinvest. Answering a few key questions can help leadership teams focus on the most critical traceability applications:

- What is the strategic context for your industry, and what near-term and long-term goals are you trying to achieve?

69%

of consumers
would pay more for
sustainably sourced
electronics

- Which processes or inputs to a product do customers or regulators care about most?
- What new capabilities would deliver a competitive advantage in terms of unit economics, resilience and sustainability?
- Where could a circular value chain help unlock new business opportunities and give rise to new business models?

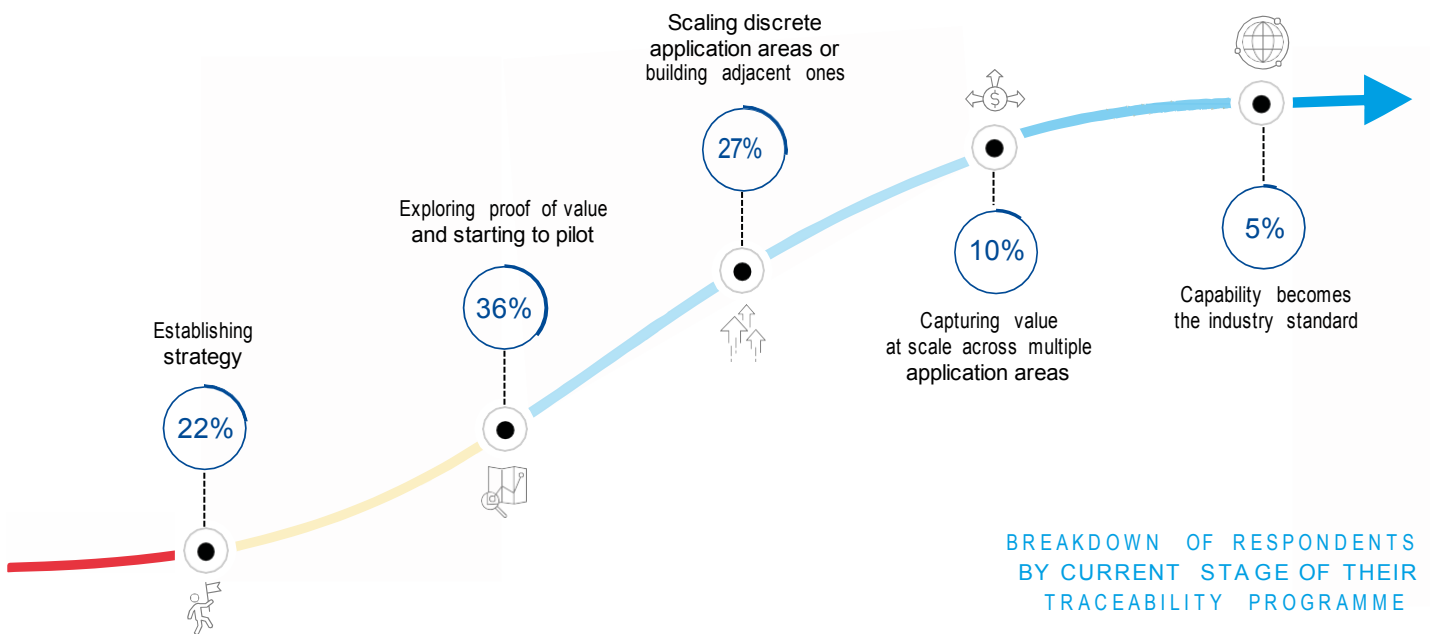
Once leadership teams get the first applications up and running, they can amplify the benefits by adding complementary applications that share common data requirements or a common set of ecosystem partners.

In addition to defining the strategic context and potential sources of value, leadership teams need to assess the maturity of their existing tracing

capability relative to peers. That means looking at value chain visibility upstream and downstream and identifying any gaps. It also involves analysing the company's position relative to the competition and determining whether suppliers or other partners in the value chain are developing powerful traceability applications.

Leadership teams can determine how fast they need to move by assessing the company's starting point and competitors' commitment to traceability. That approach makes sense for companies striving to catch up from behind and for those jockeying to stay ahead of the pack. It will also help identify potential ecosystem partners. Our research shows most companies are still at the beginning of their traceability journey. Only 15% have made progress investing in traceability technology and scaling it, and 22% are at the beginning of the journey, stuck in the strategy definition stage (see Figure 2).

FIGURE 2 How traceability programmes mature



Source: Bain 2021 Global State of Traceability Survey (n=153)

One important exercise in understanding the company's starting position is assessing the key enablers to traceability. They include the operating model, cross-functional engagement, external collaborations, partner ecosystem, technology, data, standards and certifications. Of course, a critical part of a company's internal readiness analysis is executive alignment on the need for traceability.

Once companies have a good sense of their point of departure, they can start formulating a path forward. Global auto supplier Bosch, for example, took time to do a thorough diagnostic and identified two focus areas for pilots to optimize carbon emissions. That gave the firm a vital foundation to launch those application areas worldwide.

Beginning the journey

2.1 Connecting traceability to sustainability and business objectives

The two primary business objectives for supply chain management over the past century have been reliability and efficiency. To compete effectively, companies now need to ensure their entire value chains are also sustainable and resilient. That means looking beyond the materials provided by a company's Tier 1 suppliers and the first line of customers who purchase their goods. The broader value chain includes every supplier's supplier and every customer's customer. In addition, they also must meet rising consumer demands for speed and customization, as well as stringent new regulations and evolving certifications and standards. This expanding number of objectives is making value chain management enormously complex.

This complexity poses a huge challenge but managing it well can create a powerful competitive edge. The ability to trace products throughout a value chain will allow leadership teams to transform their operations and create new business models.

Traceability applications connect an ecosystem of partners that can spur additional value creation via increased visibility, collaboration and system-wide innovation. Leading companies in digital traceability understand that it is both an offensive and a defensive strategy, anchored in the company's core objectives. For these leaders, the role of the value chain goes far beyond fulfilment. It's a new competitive ace.

Our research shows that executives are relying on traceability to pursue multiple objectives related to value chain performance (see Figure 3). Today, their No. 1 goal is regulatory compliance. But they consider value chain reliability and digital engagement with the customer in real time nearly as important. Other top applications include efficiency, sustainability, resiliency and security. As a result, the most powerful traceability applications areas support multiple objectives.

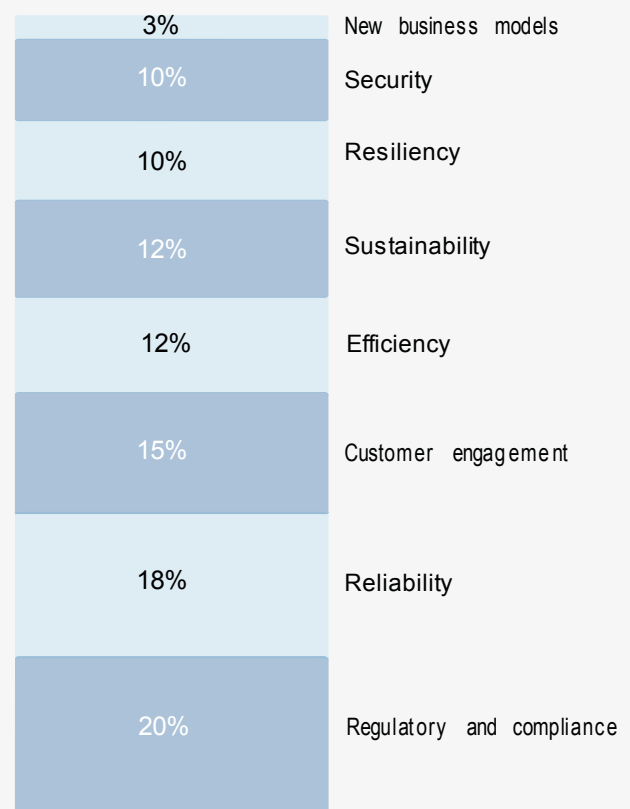
FIGURE 3 Executives' top goals for traceability initiatives

Percentage breakdown of respondents to the question

WHAT IS THE MOST IMPORTANT OUTCOME YOUR COMPANY WANTS FROM TRACEABILITY?



Source: Bain 2021 Global State of Traceability Survey (n=153)



A few leading companies are already using traceability tools to develop new business models through precompetitive collaboration. Ralph Lauren, for example, invested in traceability to support sustainability in its core business and to create new business opportunities. As the secondary market for luxury goods took off, the firm's executive team decided to build a traceability platform that would help consumers verify the authenticity of Ralph Lauren products being resold on digital platforms. The application, built together with EVERYTHING, Depop and Vestiaire, gives Ralph Lauren a connection to secondary market consumers while also prolonging the lifespan of its garments. Importantly, the traceability application helps curb counterfeit clothing that typically is produced in unregulated and dangerous working conditions and may contain harmful inputs. The authenticity application will enable Ralph Lauren to pursue new business models in the secondary market together with other ecosystem partners and in new customer segments.

Ralph Lauren's approach underscores how vital traceability will become as economies and business models become more circular. To reuse,

remanufacture, or recycle products and materials, for instance, companies will need to know where products end up after they are sold and used. Some leadership teams may consider the gathering of such information as the cost of doing business, but others realize it also can provide the foundation for new growth.

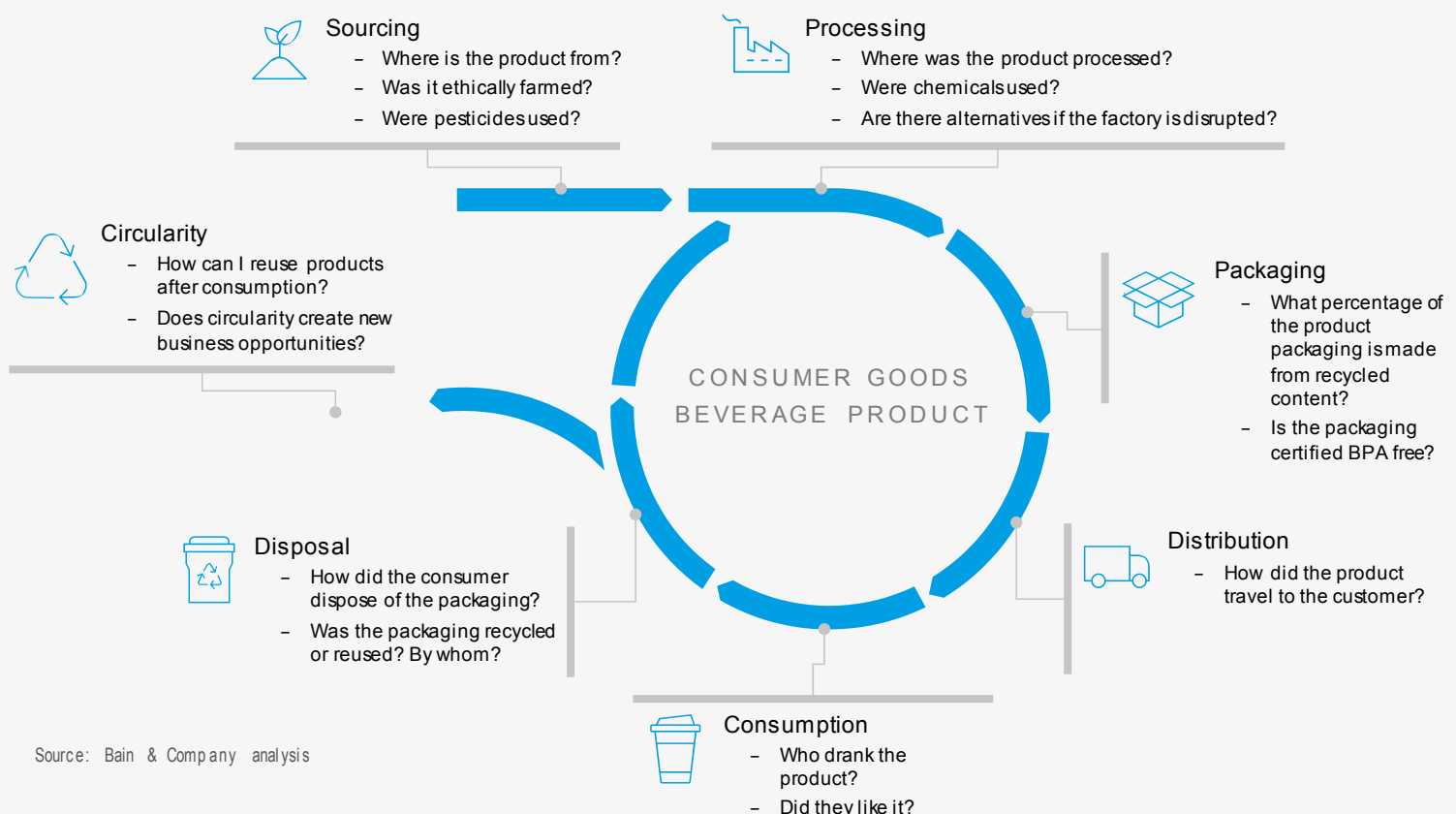
Of course, companies achieve the full value of any application when they scale it across their own value chain or the sector's value chain. In our experience, many traceability projects get stuck in pilot mode and lose momentum or fail to scale. Companies that roll out successful, large-scale traceability platforms plan the macro journey from strategy to implementation before they launch the first smaller-scale pilots. They identify their value chain objectives, potential trade-offs and pilot initiatives that can produce value across the entire supply network. And, before getting started, they determine the key enablers, how to scale the first applications and how to communicate with stakeholders. Companies that delay this essential planning step risk launching a pilot application only to discover it cannot be scaled.

Getting started

Leaders seek opportunities to benefit from traceability across the entire value chain. They may choose to optimize product design by trimming costs, improving the carbon footprint, or increasing resilience of inputs or conversion (see Figure 4). Often, these traceability efforts include application areas related to circular

value chains – including the reuse of inputs – making it easier, faster and cheaper to remanufacture products or recycle goods back into the supply ecosystem. Of course, when supply or demand shocks hit, improved value chain visibility allows companies to respond quickly to changing business conditions.

FIGURE 4 Traceability delivers value on multiple fronts





Choosing the first pilot can feel overwhelming because traceability applications address such a wide array of objectives. But the bigger risk at this early stage is getting stuck in over-analysing the options. Leaders often use a rapid test-and-learn approach once they select the first pilots to help build the organizational muscle for present and future tracing applications. Five key steps can help companies quickly narrow the choices to a handful of application areas:

- Start with strategy. Link the priority application areas to the company's overall ambition, strategy and specific opportunities for value creation and sustainability. In short, start with a clear sense of objectives.
- Within the strategic priorities, focus on application areas that will create immediate value – not necessarily the highest value. Select

those that will help energize internal and external stakeholders by convincing them of the benefits of a shared ecosystem. And communicate joint objectives frequently to build momentum.

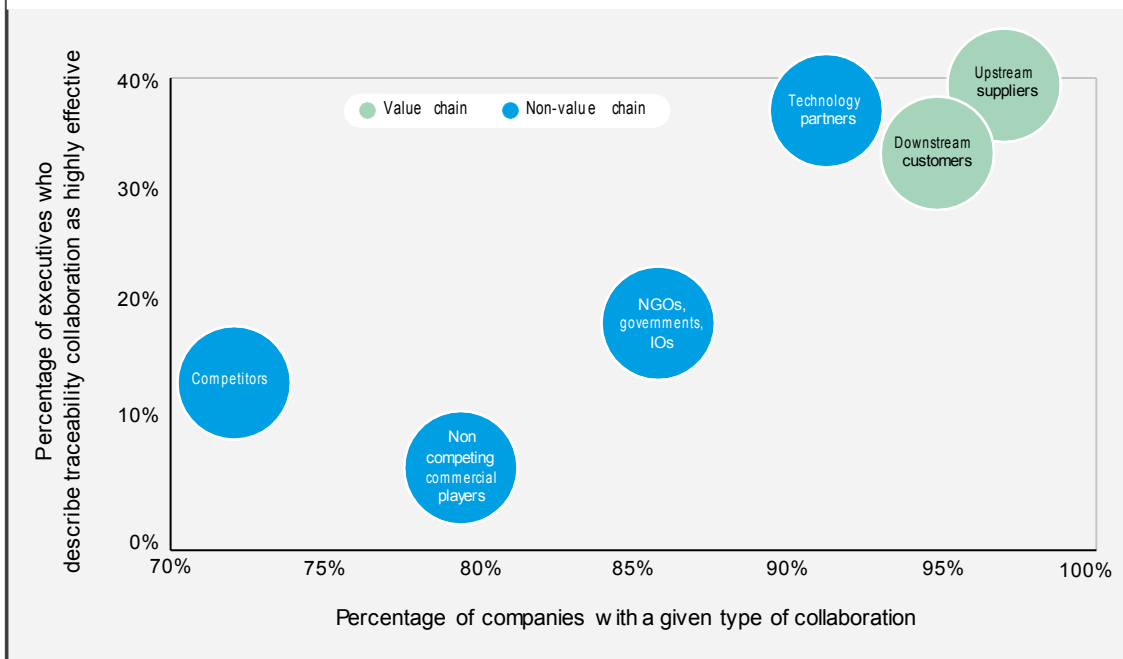
- Focus on application areas that help build the organizational muscles for implementation. Traceability is a journey that will benefit from organizational learning and improve the company's capabilities.
- When expanding beyond the first application areas, choose complementary applications that share the same enablers to accelerate scaling and amplify results.
- Prioritize implementation areas where you can influence how other members of the ecosystem behave.

Collaboration priorities

Successful traceability efforts require collaboration. No company, no matter how large, can collect all the relevant information needed for robust traceability. In fact, the value created by traceability technologies results from data sharing and collective standards among companies throughout the value chain. So, partnering strengthens the competitive advantage of individual companies and the community ecosystem.

Most firms understand that collaboration is important but they fall short on implementing a robust set of partnerships (see Figure 5). One reason this occurs is because companies are not used to collaborating with anyone outside their business operations, such as competitors or Tier 2 suppliers. Emerging technologies and the right platform model can make cooperation easier (this will be covered in Section 3).

FIGURE 5 | Traceability partnership capabilities are still nascent at most companies



Source: Bain 2021 Global State of Traceability Survey (n=153)

How can a group of firms that compete within the same value chain collaborate on a traceability solution without losing their competitive advantages? We believe that, in most circumstances, the benefits of collaboration outweigh the downsides. Co-creating technology solutions and collaboration standards in a pre-competitive space can reduce the cost for everyone. Pooling influence to convince powerful or less collaborative firms to share required information can also develop high-impact traceability ecosystems.

While collaborating with others can give companies access to vital information, it is up to each organization to translate this information into insights and build the required business processes that will transform insights into competitive advantage. The companies that build the best value-creation model linked to traceability will outperform the competition. In the future, we believe all companies will have similar access to traceability data. The winners will be those that wield the data skilfully to improve business processes and outcomes.

Igniting the collaborations

Leaders in traceability know that an effective ecosystem requires partners from every part of the value chain. They also understand the forces that can help overcome natural barriers to collaboration and convince reluctant stakeholders to team up. Since most companies are committed to sustainability, an alliance built around sustainability metrics may be the easiest starting point for a partnership. And collaboration can build trust.

The next important step is to identify the primary force in a sector to accelerate collaboration and energize traceability ecosystems. Consumers, customers, suppliers, manufacturers, regulators and NGOs can each act as a powerful engine for partnering. For example, customers and consumers may bring pressure on suppliers and distributors by

demanding traceability requirements. Manufacturers may see an opportunity to use traceability to differentiate themselves, improve their operations and processes, and build alliances with other manufacturers that share the same suppliers but operate in different industries. Of course, new regulations for the disposal or recycling of finished goods puts pressure on manufacturers to develop traceability solutions, but this also presents an opportunity for manufacturers to reduce costs associated with materials as they increase their ability to reuse and remanufacture. And governments may insist on knowing what a product is made of before they will purchase it or levy import taxes and tariffs, creating an incentive for a traceability platform that benefits every member.

Defining a collaboration strategy

Traceability collaboration strategies need to be built on trust. Though some partners will be more committed than others, successful partnerships ensure that each member benefits from traceability and helps steer decisions instead of being forced to participate.

Each company should define its position in the ecosystem and its role connecting the disparate parts (see Figure 6). Are you the heavyweight force that convenes other members, a key influencer or participant in traceability applications, or a follower but one that is enthusiastic to help bring others on board?

Conveners typically are the most powerful members in the value chain. They have the ability to bring others to the table, set the rules of engagement and develop the traceability applications that solve their biggest pain points first. For example, *conveners* can establish the rules for sharing information and define the objectives of the group. They also lead the process for scaling and decide when to bring other partners into the ecosystem. The *convenor* role is particularly interesting for companies that are a principal hub in the ecosystem and expect a significant return on traceability investments. A major agriculture producer may decide to act as *convenor* and bring together different members of the value chain if it believes a common set of data standards will create value for everyone, including customers.

Companies that are not starting from a position of strength in the ecosystem, but who will benefit significantly from traceability, can play an active role as *alliance brokers* to achieve their goals. They connect with members of the value chain and

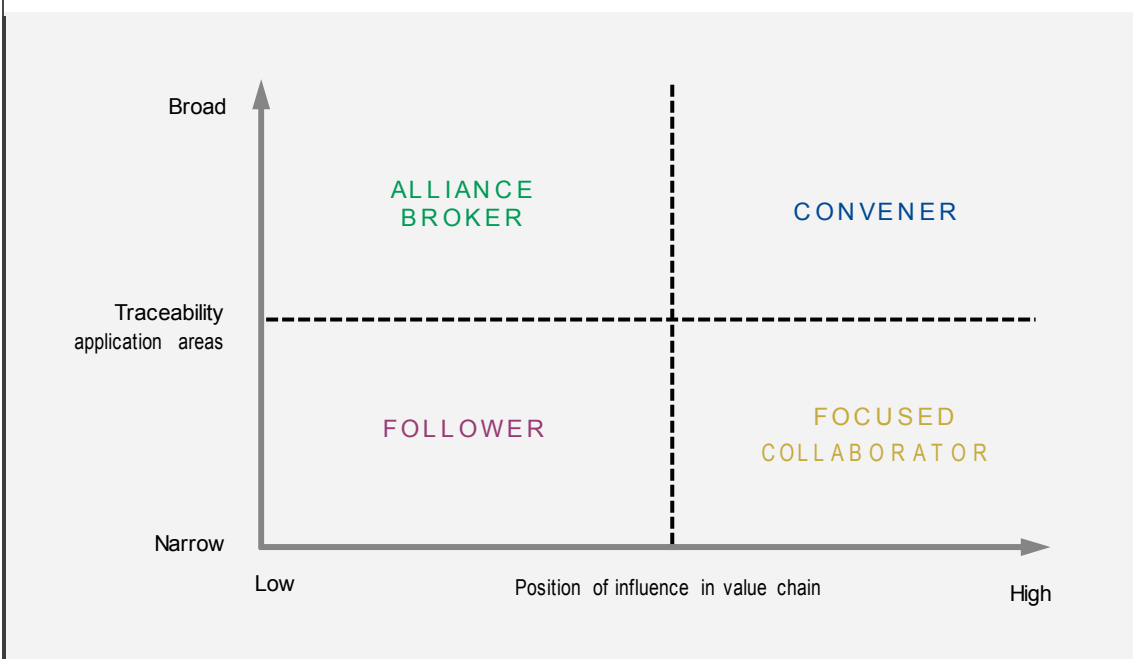
highlight the benefits of a traceability alliance. For instance, a supplier to battery makers for electric vehicles may decide to broker an alliance between some or all of the major battery makers and the major automotive companies to enable effective recycling of the battery. One of the large automotive companies or battery makers would need to take the lead and set the standards for the supply base, but the alliance broker plays a key role convincing value chain members that everyone would benefit from an integrated approach to recycling.

In sectors with narrower application areas for traceability, many leading companies play the role of a *focused collaborator*, building a select set of partnerships that deliver valuable information about special application areas. One example might be a steel company positioned at the top of the value chain. With fewer members in its overall supply chain, the firm and its mills can effectively trace inputs, providing significant value to a large number of stakeholders downstream on the recycled content of steel.

Followers in industry typically do not have many advantages. But in traceability ecosystems, the network benefits increase as new partners join. This dynamic may create interesting opportunities for smaller players to join sector initiatives.

Large firms with complex organizations will need to define the role of each business unit in traceability. Many of these companies may simultaneously be *conveners*, *alliance brokers*, *focused collaborators* and even *followers*, depending on the application area and their position in the respective value chains.

FIGURE 6 Four traceability collaboration strategies



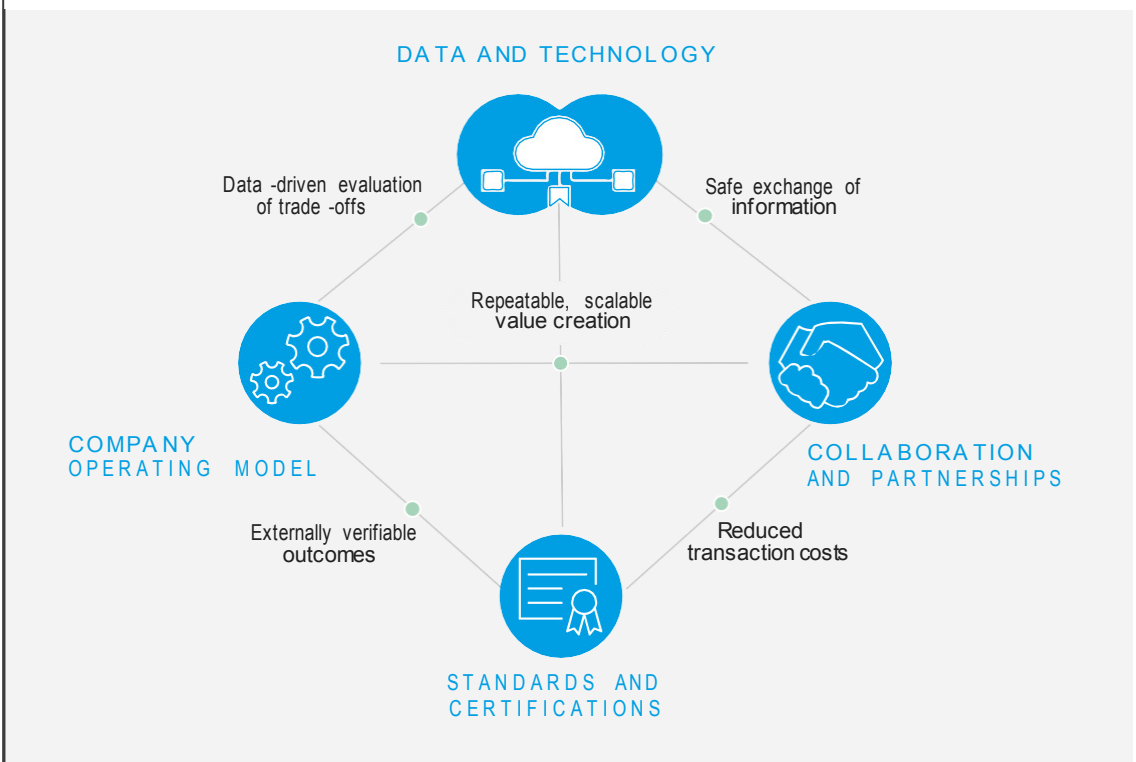
Source: Bain & Company analysis

Understanding the traceability enablers

Leadership teams can help ensure the success of their traceability strategy by strengthening five key enablers. These include an internal operating model adapted to cross-functional strategies, a partner ecosystem, integrated data strategy, robust technology architecture, and alignment on standards and certifications. Too often, companies focus on only one or two of these capabilities and

overlook how interconnected they all are (see Figure 7). To achieve the full potential of a traceability transformation, executives need to understand how each enabler positively reinforces the others. Likewise, they need to make sure the enablers don't impede one another, such as a technology that doesn't support the operating model or the collaboration strategy.

FIGURE 7 Traceability enablers are deeply interrelated



Source: Bain & Company analysis

Internal operating model

Traditional operating models tend to undermine traceability. Organizational silos and hierarchies often obstruct the optimization of business processes that span the value chain and cross-functional initiatives that depend on internal collaboration. Typically, there is no department or executive – apart from the CEO – responsible for setting goals, dedicating resources and drafting budgets for initiatives that span the entire value chain. In fact, many companies hand over responsibility for the traceability strategy to the chief sustainability officer. Often, however, sustainability departments are stymied by insufficient resources

or influence to make substantive changes to their organizations' operations strategies, let alone champion traceability.

Even if sustainability departments were flush with resources, there's a logical reason why the business and profit-and-loss owners should oversee traceability strategy and implementation. Traceability helps companies deliver sustainability goals; it also enables business model innovation, resilience and operational excellence. To tap the full benefits of traceability, leadership teams need to manage their traceability investments as a broad business-wide

objective. That's why the chief technology officer, like the sustainability chief, should support but not lead traceability initiatives.

Olam, a global food and agribusiness company based in Singapore, started with a focus on sustainability but quickly realized traceability was a strategic capability for the entire organization. The company is now reshaping its operating model to support traceability more effectively and building a broader dataset that includes all major food suppliers.

Companies that achieve large-scale traceability design an operating model based on their long-term traceability ambitions – not their initial requirements. But they set incremental milestones to build momentum through quick wins that help build trust. They start by clarifying their traceability

objectives and the potential value creation across the business. These companies integrate long-term budget needs and executive support for traceability in their planning. To ensure a smooth process, they deploy cross-functional teams along with line leaders and rely on agile ways of working in design, implementation and scaling.

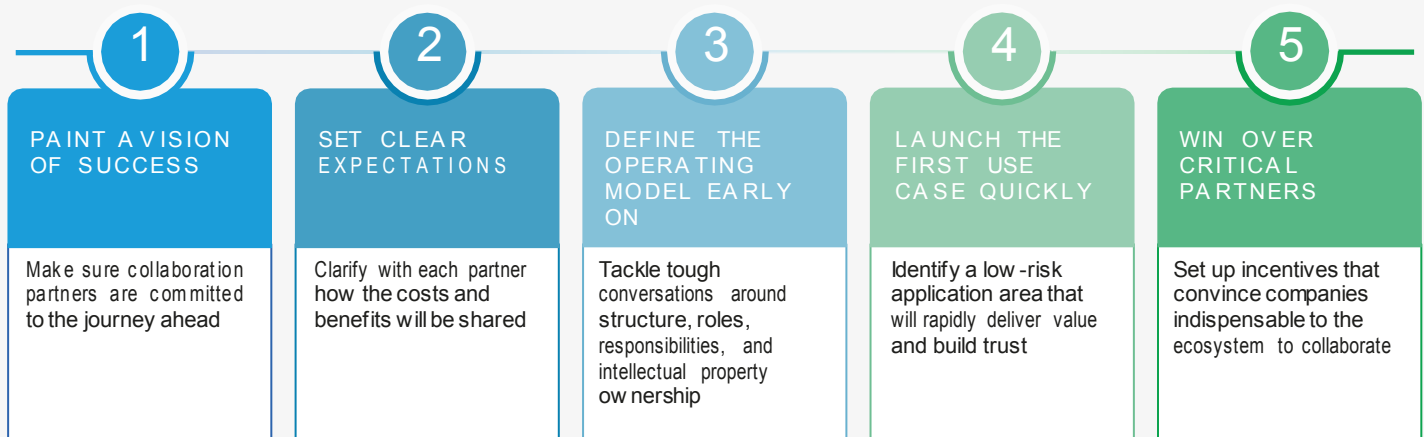
The more common approach is often unsuccessful – executive teams launch a smattering of disconnected traceability pilots with no overarching strategy for scaling them. If the procurement team works on supplier traceability, the sustainability team targets carbon emissions, and the marketing department focuses on input traceability and certifications without an integrated roadmap, these isolated efforts may be difficult to scale organization-wide.

Collaboration and partner ecosystem

If it is difficult to get internal coordination and collaboration right, it is even harder to set up an operating model that facilitates collaboration with suppliers, distributors and other members of the value chain. Our research shows most companies have launched collaborations with their value chain partners, but less than 40% describe the collaboration as highly effective.

Yet collaboration is essential to value chain traceability and to competing in a changing business landscape. Increasingly, organizations will need strategic partnerships at every node in their value chain. Some 64% of executives responding to Bain's Global State of Traceability survey said collaboration is very or extremely important to access traceability information. Again, the enormous scope of the potential partner ecosystem can be overwhelming. Focusing on the company's traceability applications will help narrow the pool of critical partners.

FIGURE 8 Five practices that raise the effectiveness of partner collaborations



In our work with traceability leaders, we identified five practices that raise the effectiveness of partner collaborations (see Figure 8). The first is to ensure that collaboration partners are both committed and enthusiastic about the journey ahead. In defining the value proposition for the group, it's vital to educate partners about the entire array

of benefits traceability offers each of them. The collaboration proposal should incorporate each partner's individual interests and concerns. And if some companies essential to the ecosystem are not immediately keen to join, a clear statement of the strategic rationale, benefits and risk mitigators will increase the chances of success.

Second, each partner needs to understand how the costs and benefits will be shared. Partners who do not see a meaningful benefit or who bear too much of the costs inevitably will stop investing. Clarify how traceability will allow members to differentiate themselves in the marketplace without undue risk. One of the most compelling arguments for potential partners is securing a competitive advantage for a product or service that provides traceability insights to consumers. Another benefit is sharing the financial burden to obtain traceability information that benefits multiple parties. Some partners may also be eager to create standards for exchanging traceability information, improving interoperable solutions. Partners' rationale may vary, but a successful traceability initiative addresses each member's motivations.

Third, tackle the inevitably tough conversations on roles, responsibilities and structure. That will pave the way for clear rules of engagement. Partnerships that race out of the starting gate without defining structure, roles, responsibilities and intellectual property ownership run into problems when they try to scale. Since partners may contribute financial capital, human capital, or technology, the group has to agree how to value each contribution. Successful partnerships clarify early on the information each stakeholder will be expected to share, how much each company will pay, what IP each will hold, which data ownership standards apply, and the time and resources each will dedicate.

It is also important to develop guiding principles for the collaboration community on how decisions will be made. In particular, the initial members of the group should agree on the rules for accepting new partners and identify the type of partner desired at each stage of expansion. That ensures growth is strategic and focused on adding the most relevant partners.

Fourth, avoid getting stuck pondering all the possible options. Setting up partnerships for an interdisciplinary initiative such as traceability is overwhelming. One natural pitfall is spending too much time analysing potential alternatives and pathways, resulting in a failure to act. While it is crucial to align from the beginning on the scaling model, it won't be possible to immediately identify all target partners and get them quickly on board. Leaders identify a lower-risk application area that will deliver quick value and launch a collaboration while they sort out the final details of ecosystem and platform. Experience on the ground will build trust and contribute valuable learning.

Finally, set up the right incentives so companies indispensable to the ecosystem are willing to collaborate. Several traceability applications may require data from small and technologically unsophisticated suppliers or consumers. Obtaining insights from the consumer on product location, product status and planned disposal is valuable but often challenging due to privacy considerations.

Consumer organizations can help companies develop attractive incentives that encourage consumers to collaborate. One emerging model gives consumers control over who sees their data and when. Another model creates financial incentives for collaboration by offering consumers a discount on new products if they trade in an old one.

On the supplier side, we see several incentive strategies emerging. Often, brands and manufacturers will invest in technology that enables small suppliers to get paid for sharing specific information via mobile applications. One example is [Fishcoin](#), which is a means to reward the fishing community for information about their catch. Another strategy is to share the economic rewards with suppliers. If incentives do not convince the required stakeholders to participate, the partnership needs to find a way to work around the missing link in the chain.



The right data

Digital traceability requires data and a well-designed data model. But data alone does not create value. Value comes from advanced analytics applications, prediction modelling, decision-making support and automated data exchange. Leaders wield these capabilities to extract value from traceability information.

It sounds straightforward but all too often companies rush to collect a massive amount of data only to discover it creates limited value. A more effective approach is to first define the company's objectives, then use them to determine which data is most valuable. That means thinking ahead about

future decisions, trade-offs, and forecasting and resilience requirements. As part of this process, executive teams also identify the required data granularity and processing speed.

Value-creation choices shape the data model and the analytics capabilities. To get started, map the data required across the target traceability applications (see Figure 9). The resulting matrix quickly helps identify synergies between application areas and data requirements. It also suggests which traceability information to focus on first. This strategic approach eliminates the risk of gathering data that does not lead to insights.

FIGURE 9 Example of data-requirements mapping

Data fields	Application area and level of visibility required						
	Sub-tier single sourcing	Geographic exposure	Product security	Carbon emissions	Recycled content	Ethical labour	Conflict minerals
	Tier 4 suppliers	Location of Tier 2 factories	Component serialization from Tier 3	Tier 5 raw material suppliers	Tier 4 suppliers	Network certification statuses	Mines in network
Supplier names	✓	✗	✓	✗	✗	✓	✓
Supplier site locations	✓	✓	✓	✗	✗	✓	✓
Material or component input by supplier	✓	✓	✓	✗	✓	✗	✓
Supplier audits	✗	✗	✓	✓	✓	✓	✓
Shipment dates and times	✗	✗	✓	✗	✗	✗	✗
Material or component weight (volumes)	✗	✓	✗	✗	✓	✗	✗
Quantity of GHG emissions	✗	✗	✗	✓	✗	✗	✗

Source: Bain & Company analysis



Traceability partnerships face two big data-related hurdles: sharing data effectively across company borders, and creating a trustworthy dataset and protocols. Leading companies develop solutions together with their ecosystem partners. For example, the partnership can reduce data cleansing and preparation time by creating standards together for unique identifiers for products (e.g., Global Trade Item Number and barcodes) or for sharing location information or events (e.g., GST2, Global Location Number). Selecting specific application areas that create value for all partners can increase their willingness to share data or to start collecting it.

Lenzing Group, a global leader in the production of sustainable cellulosic fibres, developed a digital

solution with key partners to enable traceability collaboration across the entire value chain, encouraging multiple stakeholders to join its ecosystem.

It is also crucial to ensure data security and privacy for each member of a traceability ecosystem. Every traceability solution needs to meet state-of-the-art cybersecurity standards. The good news is that innovation in data storage is improving the ability to manage which stakeholders can view specific datasets and when they have access to them. Ecosystem partners need to jointly define the rules and guiding principles for privacy, security, and access rights. (More to come on this topic in the next section.)

The right technology

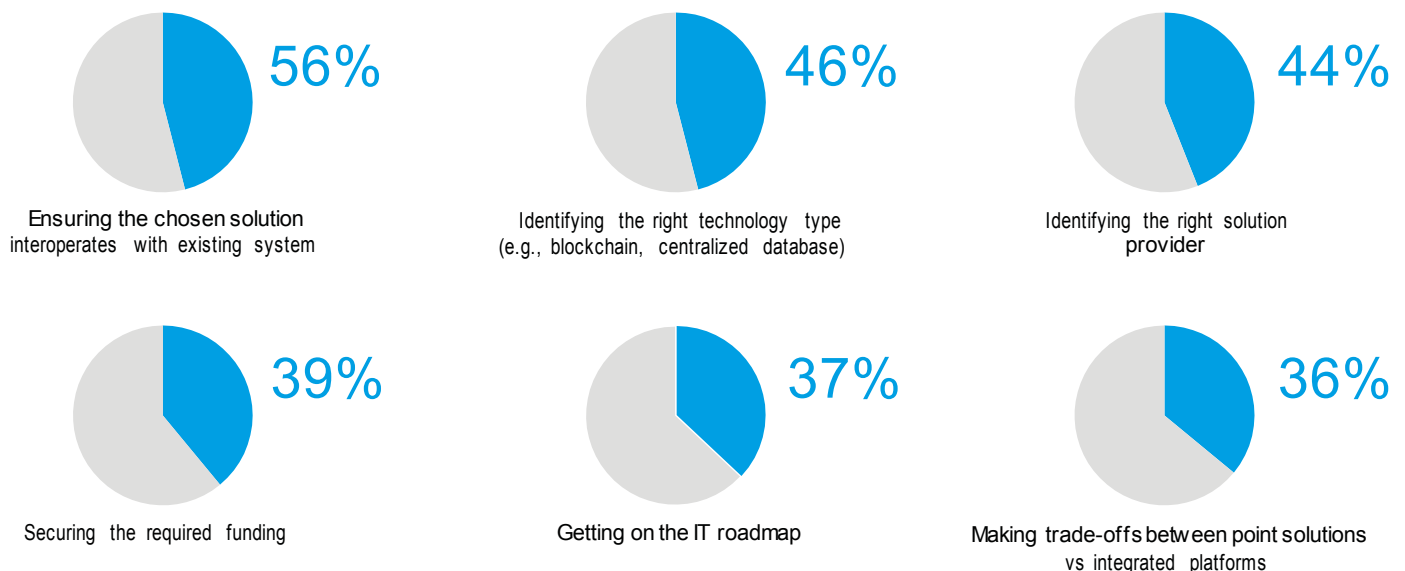
How can executives make sure they choose the right traceability technology? They start with the desired outcomes and use a systematic decision-making process. Once companies prioritize their traceability goals, they can zero in on the technology that will deliver them. Leading companies and traceability alliances address a number of key questions before making technology decisions and commitments. Here are just a few examples:

- What business goals do you want to achieve with the traceability application?
- Do you understand internal stakeholders' requirements?
- What level of data granularity do you require?
- Do you have relationships with the parties that control the data needed for your application?

Today's challenge is not the availability of good technology solutions—in fact, we are encouraged by the quantity available and the pace at which the market is evolving. The hard part is choosing the best match for a specific set of traceability objectives, integrating the chosen solution with existing systems, and ensuring interoperability with other solutions in the value chain (see Figure 10). In some cases, companies will be able to find off-the-shelf software or assemble a mix of applications to meet their goals. Innovative applications might require in-house development or cocreation with vendors. Up to now, we have seen an even split between companies sourcing an off-the-shelf, best-of-breed solution, building their own application in-house, or cocreating it with partners. There is no right or wrong answer. The choice depends on the traceability application area, targeted outcomes, and each firm's development capabilities.

FIGURE 10 Key traceability technology challenges

Percentage of executives who said this factor is a key traceability challenge



But that's just the first step in a complex journey. In addition to finding the right solutions, companies must identify the right solution provider, ensure interoperability with source systems, agree on how to fund what ultimately will be a shared platform, and align on trade-offs between individual solutions that address a specific application area versus integrated platforms. And, given the rapid pace of innovation, companies have to make a few select bets while avoiding overdependence on a single provider.

Leading companies are building adaptive, secure technology architectures that allow them to incorporate innovative new solutions with an agile test-learn-pivot approach. Adaptive technology architectures give companies the ability to add new capabilities to legacy systems in a flexible, scalable way.

One challenge is developing a more flexible IT architecture that protects privacy and security while still allowing data exchange with ecosystem partners. IT leaders invest in a more modularized systems architecture using microservices and software-as-a-service applications around a smaller enterprise resource planning (ERP) core. These architectures also incorporate existing communication standards to facilitate processing and sharing of information between partners (e.g., [EPC Information Services Standard](#) or the [Global Data Synchronization Network](#)).

Companies also must navigate the large number of technology building blocks (see Figure 11). The vendor pool is also expanding rapidly and includes traditional supply chain software providers, start-ups focusing on circular economy and sustainability applications, and big tech giants offering their infrastructure and services for traceability applications.

FIGURE 11 Traceability technology building blocks

Technology building blocks	Why would you need it?
Enterprise technology	
ERP (Enterprise resource planning)	Manage transactions of key business functions (sales, delivery, returns, production, procurement, finance)
MES (Manufacturing execution system)	Information about production process required
CRM (Customer relationship management)	Customer and point of sales information required
Data exchange	Managing data exchange between internal and external parties
Cloud data platforms	Ingest, store, process, and serve data using scalable and secure cloud infrastructures
Analytics engine	Gain insights from data through advanced analytics
Blockchain	
Public blockchain	Interaction with unknown actors Immutability of records required Smart contracts
Private blockchain	Interactions only with known actors Immutability of records required Smart contracts
Internet of things	
5G	High bandwidth mobile connectivity
RFID (Radio-frequency identification) / Sensors	Wireless noncontact, non-line-of-sight tracking and tagging
GPS (Global positioning system)	Geolocation of assets Physical traceability of goods and shipments

Source: Bain & Company analysis

Certifications and standards

Companies are increasingly being held accountable for the actions of their business partners and their partners' partners. Supply chain managers need to document the country of origin of each component, even those coming indirectly through suppliers' suppliers – and sometimes even the region or specific production site. The auto industry offers a recent example of growing demands for value chain transparency. Companies that make batteries for electric vehicles increasingly need to prove that their cobalt and lithium doesn't come from regions that use forced labour. And it's not only stakeholders that are demanding change. Governments are beginning to mandate greater transparency in some industries. A proposed German supply chain law adopted on 11 July 2021 will require companies to conduct human rights due diligence in their value chains, going beyond their direct suppliers.

How can companies that lack visibility in their sub-tier suppliers solve this challenge? Certifications that prove sustainability commitments play a critical role. These are formal attestations by a recognized authority. Companies need to decide which certifications are most relevant for their value chain and which types of certifications are most valuable.

Certification involves a number of complex issues that companies need to address, including certificate proliferation, greenwashing, trust and privacy:

- Certificate proliferation and complexity. As consumers demand more transparency, the number of competing labels attesting to environmental, social sustainability or other qualities – such as Fairtrade and UTZ/Rainforest Alliance for cocoa – are proliferating.
- Greenwashing. The term greenwashing refers to deceptive corporate marketing campaigns that seek to persuade the public that the company's products, aims and policies are environmentally friendly. A related practice is providing financial support to a sustainability initiative or group in order to use their green labels without having to prove that the company's products or processes meet clearly defined metrics.
- Trust. As certificates proliferate, consumers may lose trust in labels, particularly if they are not tied to a credible standard. One major source of mistrust is company-specific labels, which NGOs have criticized for lowering standards and transparency.
- Data privacy. Consumers are deeply concerned about how companies may use their data for traceability. Nevertheless, when it comes to circular business models, companies will need to trace information through the usage to further processing, including recycling or remanufacturing.

- Standards. Most industries have established standards for exchanging sustainability information. Examples include standards for electronic data exchange and agreed practices such as using a QR code to mark each product. Standards act as a common business language, making collaboration among multiple stakeholders smooth and efficient.

Broadly, there are two types of traceability certifications. The first type audits policies and processes, determining, for example, whether a technology tool does what it is supposed to do. The second type controls outcomes and products. For example, did the company really achieve carbon neutrality, or did the single-origin chocolate really come from a specific farm in Costa Rica? Product certifications are more visible to consumers as they typically appear on product labels. There are three common product certifications: product segregation, mass balance, and book-and-claim.

Both types of traceability certification prove a company's commitment to specific goals and outcomes are often reflected in product labels or business seals. While most certifications to date are based on process (how a product is made), we believe the trend in the coming decade will be towards outcome-based product certifications that require traceability.

In 2020, more than 120 global CEOs collaborated at the World Economic Forum's International Business Council (IBC) to agree on a set of environmental, social and governance (ESG) metrics, the Stakeholder Capitalism Metrics. The set consists of 21 core and 34 expanded metrics released in September 2020 and builds on the United Nations' ESG framework. Since then, more than 60 companies from various industries have already announced their commitment to report on these ESG ratings. This commitment to a consensus-based standard showcases how industry leaders can agree on a standard for certification or rating with a common set of metrics for any entity while also being flexible about specific demands through expanded metrics.

Over time, if sectors or sector leaders don't define the certification standards, other stakeholders are likely to create them. The push for standards may come from consumers, investors, regulatory bodies, or governments. To stay out in front of the debate, leading companies work with NPOs or NGOs and sector leaders to define rules and set standards. They focus on not only *which* metrics to share but how to calculate them. Leaders also provide guidance to governments on *how to* improve traceability (e.g., [Wyoming blockchain laws](#)). That includes identifying infrastructure support that would enhance traceability efforts (e.g., government-owned recycling centres).

From experimentation to transformation

Traceability efforts often start with small, time-limited pilot projects focused on a specific material, product, supplier or geography. Leadership teams typically give these projects special attention and resources. A small project is the best way to start because it quickly demonstrates the potential value of tracing and allows partners to test and learn together. However, companies can only see the full value of a traceability effort by scaling the capability and embedding it in standard business processes.

The biggest mistake companies and partnerships make when investing in traceability is to delay planning how to scale their pilot. Postponing that scaling plan until the pilot is up and running inevitably results in challenges with the data, technology, operating model and growth in the ecosystem.

Specifically, companies leading in traceability consider four scaling options or vectors when determining the logical order for expanding their pilots. The first is how to improve the quality or robustness of the initial application with the existing partners. The group may add new features or functionality, for instance, or it may add new streams of data.

The second option is expanding the collaboration to include new partners – either horizontally in the same parts of the value chain or vertically in new areas of the value chain – in an effort to establish the application as an industry standard. Surgere developed its AutoSphere application together with auto manufacturers and Tier 1 suppliers, creating an auto industry standard for traceability.

A third option is adding a new application area with existing partners. In this case, the best choice is one that builds on existing applications and provides new paths to value creation. For example, a group of companies that have been partnering together on applications that trace provenance of supply may launch an initiative to also trace and recycle final products.

The final option is starting a new application with new partners. Companies should avoid doing this until they have successfully scaled existing pilots. The risk of establishing a new partnership too early is creating multiple disconnected pilots that do not generate significant value.

Using a roadmap for each of these scaling options, leadership teams can develop a scaling plan for each traceability enabler. The plans would highlight how to expand an application area by improving the functionality of the technology platform, for example, or by gathering additional data. Executives should also plot how the platform can accommodate additional partners and fairly allocate benefits and costs. Finally, they can consider complementary use cases that reinforce or leverage each other's enablers.

Of course, success breeds success, attracting others to the fold. So, part of the scaling journey is communicating results clearly to all relevant parties – early and often. The role of individual executives within companies and exemplary firms within sectors is paramount. These leaders remove obstacles, ensure coordination, bring the vision and results to life, and ensure that partners exchange learnings and best practices.





A call to action

The pressure is growing on leadership teams in every industry to deliver on the bold sustainability commitments. At the same time, investors, governments and other stakeholders are raising the bar by demanding a higher degree of commitment and specific, verifiable outcomes. No company will be able to solve the complex issues underpinning sustainability alone. Building sustainable value chains will take a strong commitment and collaboration between public and private actors.

In addition to sustainable outcomes, companies must deliver higher performance and resilience in an increasingly volatile global economy. Traceability can help companies achieve all those goals and contribute to a powerful competitive advantage.

Despite those benefits, more than half of the 150+ companies that responded to Bain's Global State of Traceability survey remain stuck in the earliest phases – establishing their strategy or exploring proof of value. Only about 10% are managing partnerships that capture significant value. Even fewer are using their lead to set an industry standard.

Again, in the coming decade, we expect to see two distinct performance curves in each industry sector: a high-performance curve made up of companies that can digitally see and trace across their value chains, and a lower-performance curve consisting of those that cannot.

For leadership teams evaluating their options, it's time to act. For those piloting and experimenting, it's time to scale. And for companies operating full-scale projects, it's time to amplify the benefits.

To support the creation of broad traceability ecosystems, the World Economic Forum's Platform for Shaping the Future of Advanced Manufacturing and Value Chains has established a traceability community (See Figure 12). The community is bringing leaders in operations and supply chain together to share best practices, codify toolkits and set up training programmes, sponsor working teams to solve key traceability challenges, and communicate success stories to recognize achievement and incentivize others to start the journey. We encourage you to join us in this journey together.

FIGURE 12 Key traceability technology challenges

Connect



Help industry leaders exchange ideas and results

Share



Codify best practices and case studies from leading application areas

Learn



Launch Traceability Academy training and executive workshops

Collaborate



Expand traceability toolkit; perform proof of concept for specific applications

Advise



Support companies as they design, launch, and scale applications

Promote



Celebrate traceability leaders and industry-wide results

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