

# Sustainable supply chains using distributed ledger technologies



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Supply chain sustainability has become a key goal for many enterprises as there is an increasing pressure to measure the environmental impact of goods and services along their complete value chains. A regular customer or a consumer has become more demanding and selective in choosing vendors and products that provide more transparency with respect to supply chain sustainability practices and procedures. Conversely, enhancing sustainability performance can drive customer loyalty. The full supply chain includes areas such as sourcing, production, packaging, distribution management, warehousing, inventory management, and end-of-life management. All these aspects have potential to produce waste and harmful emissions, but there are immense opportunities for improvement through the deployment of digital technologies.

End-users that might adopt sustainability related supply chain management solutions may range from process and discrete manufacturing companies transforming raw material to finished goods and delivering it to a retail network, to wholesale or retail companies (including ecommerce) providing finished goods to end users or customers. Even potentially companies in service industries.

In this report, we focus on the benefits of deploying end-to-end digital supply chain tracking, traceability and management solutions and also the potential role of distributed ledger technologies (often referred to as 'blockchain') to support supply chain transparency. We also discuss some of the benefits of end-to-end supply chain transparency in the context of different goods.

## Benefits of Supply Chain tracking

A traditional supply chain tracking and management solution will often comprise a range of diverse components, including:

- Tracking and tracing of individual items in the supply chain.
- Tracking containers, pallets and cages that might be carrying goods as part of a supply chain.
- Road fleet management, including the tracking of vehicles used for logistics, distribution and transportation.
- Inventory management and monitoring solutions to monitor stock levels at manufacturing and warehousing sites.
- Real time location systems to track the location of assets and equipment in storage locations.
- Integration with enterprise resource planning and other decision-making systems.

Collectively, these components enable a full tracking of goods, or raw materials, through a supply chain also enabling quick decision making and real time management and optimisation of supply chains. Managers at a production facility would, for example, be able to know exactly when they can expect to receive certain supplies and also be alerted in the case of any delays. This information can be combined with production and order information along with inventory stock levels of different input materials to enable optimisation of manufacturing processes, inventory holding costs and also supply chain operations.

Besides these efficiency benefits, digital supply chain solutions also unlock significant sustainability benefits including in the areas of (hydrocarbon) fuel consumption, electricity consumption, and related CO2 emissions.

A significant driver of fuel savings is the more efficient coordination that supply chain monitoring enables between goods vehicles used for transport and the goods that they are transporting. Significant reductions in on-site idling time can be achieved by communicating and managing the real time location of vehicles and the materials that these vehicles may be carrying or collecting, managing the availability of equipment that may be needed to load or unload vehicles, and coordinating with movements of other vehicles that may be loading or unloading at the same site.



In parallel, managing on-site inventory in a way that allows supply chain optimisation can unlock significant further benefits. Typically, savings are realised by combining inbound freight loads and more efficient routing, both of which are enabled by accurate forecasting of stock levels and inventory requirements based on planned production. Lastly, fleet management solutions can extend efficiency management into the operations of individual vehicles, ensuring optimised routing and also efficient driving practices (such as avoidance of harsh acceleration and over speeding).

Efficient inventory management can reduce fuel consumption (in material handling, transportation and logistics) by around 20%, while fleet management solutions can reduce road fleet fuel consumption by a further 15%. In the case of cold chains for food, monitoring and tracking solutions can reduce wastage in transport by 30%, reducing the sustainability footprint of food sold to consumers and avoiding the generation of methane (a far more powerful greenhouse gas than CO<sub>2</sub>) by food waste sent to landfill.

The benefits of supply chain management solutions also extend to electricity consumption. Advanced inventory management solutions typically allow for reductions in inventory levels by up to 20%. In turn this allows warehouse storage facilities to be up to 20% smaller in size and so consume up to 20% less electricity for heating, lighting and cooling. Enhancing any such solution with the use of AGVs (Automated Guided Vehicles) can further reduce warehouse space needed by up to around 30% since the spacing between shelving racks can be reduced and floorspace can be used more efficiently.

Clearly, any saving achieved in fuel consumption and electricity consumption will flow directly into reductions of associated CO<sub>2</sub> emissions. Wider businesses benefits include reductions in inventory holding costs, improved production efficiency due to enhanced inventory availability. And, of course, reductions in costs flowing from the fuel and electricity savings described above.

## Benefits of Supply Chain tracking

Until now, this report has considered a traditional scope for supply chain tracking and management, including transfers between actors in a specific supply chain. However, with Environmental, Social and Governance (ESG) concerns garnering ever more focus, the concept of supply chain tracking is now extending both upstream and downstream.

Upstream extensions include the consideration of raw material sourcing with a desire to ensure that input raw materials are produced in compliance with defined corporate values. For example, manufacturers may want to ensure that raw materials are produced in a way that minimises pollution and are sourced from producers that uphold appropriate labour practices (including, for example, avoiding the use of child labour).

Extending supply chain tracking in this way typically involves many new parties and a complex web of commercial relationships. For example, a supply chain actor would no longer simply be interested to manage the supply of inbound goods from a supplier, but also would want to know full information about the origins of those goods. Ideally, it would be possible to track the raw materials used to manufacture the goods right back to source, including information about the location in which any raw materials were mined and associated working and environmental practices. Information relating to the share of any raw materials that has been sourced from recycled materials would be particularly relevant.



These kinds of considerations clearly apply to supply chains across multiple manufacturing industries, including white goods, electronics, automotive and aerospace and more. Beyond manufacturing, for instance in the case of agricultural produce and healthcare supplies, the integrity of supply chains is particularly important so that end-users can be sure that supplies have been stored and transported in appropriate conditions and have not been tampered with. In the case of paper and pulp processing and other products derived from wood, knowledge of the source of timber can be critical to support consumer markings claiming that finished goods have, for example, only involved renewably sourced materials. Similar information can be invaluable in the context of supply chains for chemicals, metals, and construction materials. Given evolving consumer demand for supply chain transparency, this kind of supply chain transparency is increasingly relevant to any supply chain in any industry, even services industries.

The tracking of carbon (CO<sub>2</sub>) emissions 'embedded' in goods at different levels of the supply chain is also becoming more important than ever. Globally, there is a trend towards the full reporting of carbon emissions related to any goods and services and carbon taxes are expected to become more widespread. In parallel, carbon trading (of carbon credits) can allow companies directly to monetise reductions in carbon emissions, including in some cases unlocking government benefits. Extending supply chain tracking all the way to source raw materials is exactly what is needed to support accurate carbon accounting for embedded carbon.

Downstream, meanwhile, extensions to traditional supply chain monitoring are primarily motivated by a desire to improve waste management and recycling. Partly this is due to expected regulatory impetus including, for example, laws relating to the recycling and re-use of end-of-life goods and placing obligations on manufacturers to track and support recycling. Specifically, in the case of any components of final goods that can be remanufactured or refurbished, full knowledge about the provenance of specific components will be invaluable to manufacturers. Enhanced traceability of components can also support more effective and efficient recall processes in the case that faults are found with component parts after complex products have been shipped.



These kinds of downstream requirements can also have significant impacts upstream. For instance, motivating 'circular' design practices so that end-of-life processing is considered at design stage. It also impacts procurement and sourcing practices, resulting in a preference for suppliers that can, in turn, support the efficient re-use and recycling of the components that comprise their contributions to finished goods.

As a result, extending the reach of supply chain tracking can unlock new ESG benefits, including relating to ensuring the appropriate processes are followed at the end-of-life of any product and that raw materials have been sourced in a responsible manner.

## Distributed Ledger as an enabling technology

The evolving supply chain tracking system as described above is clearly a highly complex concept. Firstly, every component in a potentially complex finished product must be traceable back to the raw materials used in its manufacture and also the associated working and environmental practices. Secondly, every component must be traceable down the supply chain, including to end-of-life and including scenarios where components are built into more complex products.

To support such a system, information must be able to flow both up and down supply chains in a seamless way. For instance, component manufacturers will need to know the status of any finished good that its components have been built in to, including when the finished good (or their components within the finished good) reach end-

of-life. At the point of end-of-life, reporting of any re-use or recycling should ideally be communicated back to the original manufacturer.

This is potentially a gargantuan task. Ideally, all actors along a supply chain will use common reporting practices, standards, and formats, and will share data over a common platform. But individual actors in a supply chain will generally supply multiple downstream actors and will source from multiple suppliers. Raw materials meanwhile are often traded on a commodity basis, with a wide range of potential suppliers. The challenge of migrating entire ecosystems of relevant suppliers onto a common platform would be huge and would extend across multiple industries since many component (or raw material) providers would supply customers in different industries.



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Luckily, distributed ledger technologies (DLTs) can help solve these problems to a large extent. DLTs can enable 'auditability' in contexts where the levels of systems integration that would ideally be required are simply not feasible.



## Conclusions

The benefits of supply chain tracking and management are clear and have been recognised for some time already. These techniques can unlock financial savings and reductions in associated sustainability footprints. Traditional solutions are now extending to support tracing both upstream to include raw materials and downstream to include end-of-life management. The scope of supply chain tracking and tracing solutions is also extending to include new aspects, such as wider ESG considerations around actors and components in extended supply chains.

Accordingly, modern supply chain tracking solutions can potentially be far more complex than such solutions have traditionally been. Managing this complexity, whilst ensuring that necessary information can easily flow down (and up) supply chains, will be a challenge, but it is a challenge to which distributed ledger technologies are well-suited.