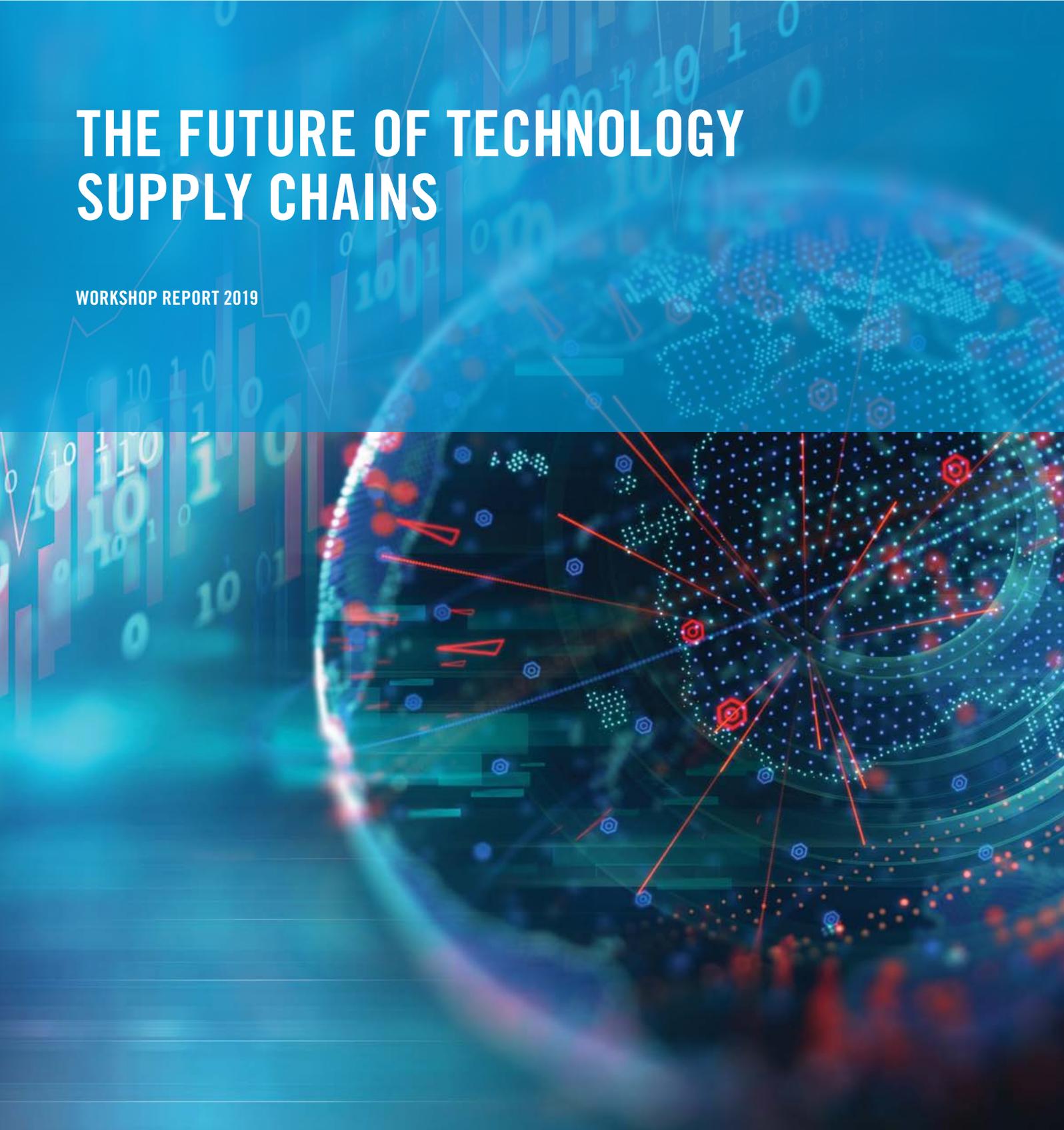


THE FUTURE OF TECHNOLOGY SUPPLY CHAINS

WORKSHOP REPORT 2019



A workshop hosted by Cambridge Consultants

Cambridge Consultants recently hosted a workshop for senior business leaders, exploring how emerging technologies will transform supply chains in the future. The workshop's charter was to identify key cross-industry sector transformations that are influencing the way products are built, distributed and consumed, and from this explore challenges and opportunities created by these transitions.

Workshop delegates represented a wide spectrum of backgrounds and expertise, including consumer electronics, industrial and pharmaceutical suppliers. With companies ranging from product designers to manufacturers, the delegates covered a broad range of technical disciplines. During a full day of insightful discussions, the participants identified key opportunities that are likely to emerge from cross-industry sector supply chain transformations.

We are grateful to our delegates for their willingness to invest significant time and effort to attend and for their readiness to share insights and opinions so freely. The report summarises the combined vision formulated during the event. It offers unique insight into the future of our industry as seen by the sectors' leading authorities.

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INTRODUCTION

Products reach consumers through increasingly intricate supply chains, involving people, organisations and processes across the world. Meanwhile, products are also incorporating increasingly advanced technologies, many of which originate from, are built by, or handled by third parties at various stages of the product development, distribution, and operational life cycles.

To some organisations, such as Apple, vertical integration provides competitive advantages. For many other organisations however, the costs involved would create prohibitive barriers to entry. Outsourcing non-core activities, such as supply of commodities, logistics and distribution, allows product development organisations to focus resources in areas where they can add most value. Nevertheless, product development companies have traditionally still played a controlling role for

the entire supply chain: developing new product offerings, sourcing components, overseeing manufacturing and assembly, and finally distributing products for retail.

Over the past decade, however, some of the most successful innovations have emerged from organisations that have harnessed the internet's ability to create new supply-demand interfaces. As a result of new digital marketplaces such as

eBay, Airbnb, Alibaba and Uber, established supply chains can be entirely bypassed and replaced.

The continued transition from simple, tightly-controlled supply chains to the complex supply and distribution systems that underpin these marketplaces, creates challenges for organisations that have relied on traditional supply chains. As new supply chains evolve in response to emerging digital marketplaces, the institutionalised trust systems that underpinned traditional supply chains will also need to evolve to support new requirements, such as improved transparency and proof of provenance.

Moreover, with traditional supply chain models, customers only get to order the product after all the product development work (including production and much of the distribution) is done. In this model, the role of the customer is limited to selecting among the available offers, and companies often need to take a gamble on how many products they will sell, leading to waste and diminished profitability.

Alternative models are now emerging, with the supply chain reacting directly to end-user demand. In this closed-loop model, customers place the order first based on a virtual inventory that is typically broader than the actual physical inventory.

At the extreme, a local, highly-automated plant produces the finished product, made-to-order and ready for delivery. Besides enabling efficiencies in inventory management, such models also enable higher degrees of personalisation.

To explore the challenges and opportunities created by these transitions Cambridge Consultants convened a workshop with influential players in senior supply chain and technology leadership roles. This report covers two central themes related to the opportunities that attracted most interest among the workshop participants. The first theme relates to opportunities that allow end-users to confidently trust the supply chains behind the products and services they use. The second theme covers opportunities that enable organisations to respond more effectively to end-user demand and rising customer expectations.

This report takes a close look at the transitions fuelling these opportunities, and how organisations can make use of existing and emerging technologies to exploit these opportunities. With rapid advancements in the technologies underpinning the transitions covered in this report, there has never been a better opportunity for new players and established organisations to build transparent, demand-driven supply chains and powerful trust relationships with end users.



WORKSHOP METHODOLOGY

To explore how emerging technologies will transform supply chains, Cambridge Consultants convened a workshop with influential players in senior supply chain and technology leadership roles. The aim of the workshop was to identify key cross-industry sector transformations that are influencing the way products are built, distributed and consumed, and from this explore challenges and opportunities created by these transitions.

The workshop participants included representatives from organisations ranging from technology suppliers, to product designers and manufacturers. The participants also represented a selection of industries including consumer electronics, industrial and pharmaceutical suppliers. During a full day of intense discussions, the participants explored key cross-industry sector supply chain transformations and the opportunities that are likely to emerge from these transformations.

As a first step, current challenges and associated opportunities were identified, discussed, prioritised and shortlisted, using

an impact-likelihood scale. The shortlisted opportunities that attracted most interest among the workshop participants related to product authenticity and traceability, improved user experience, improved operational efficiency, automation and regulatory compliance. The themes and underlying industry transformations covered in this report are the central themes that emerge from these highest scoring opportunities.

The workshop participants also discussed technologies that will enable organisations to exploit these opportunities. To help facilitate the discussion around what role technologies played, and what other innovations were necessary, we developed a set of questions covering four key layers of the supply chain digitisation stack (see figure opposite).

The rest of this report goes on to explore two central themes related to the opportunities that attracted most interest among the workshop participants.



KEY QUESTIONS TO HELP EXPLORE THE SUPPLY CHAIN DIGITISATION OPPORTUNITIES



1. DIGITISING THE PHYSICAL WORLD

If the opportunity relies on digitisation of information related to an asset and associated processes, what steps are required to extract this information?
To what level of resolution does the information need to be tracked?



2. ESTABLISHING TRUST

If the opportunity relies on digitisation of information sharing across stakeholders in the supply chain, what is the underlying trust model that allows the stakeholder to make decisions based on this information with confidence?
Do the required trust relationships exist?
Is there a need for a trusted third party to mediate trust between parties? Does this introduce unwanted/unintended consequences?



3. SETTING INFORMATION BOUNDARIES

Any opportunity that relies on digital information sharing typically also requires appropriate information boundaries. This enables those authorised to access information to have it and prevents those not authorised from obtaining it.
How are these information boundaries managed and enforced?



4. VALUE CREATION AND EXTRACTION

Does the value created from exploiting the opportunity outweigh the investment costs?
Is the value shared across all those bearing the associated costs?

THE DIGITAL ECONOMY IS RE-DEFINING HOW CONSUMERS OBTAIN SERVICES, INFORMATION AND GOODS

TRUST SYSTEMS HAVE BEEN INSTRUMENTAL TO SUPPLY CHAIN DEVELOPMENTS

Since the beginning of trade, economic expansion has been accompanied by the creation of new trust systems – from interpersonal reputation, through contracts, to today's corporate brands.

Trust is an abstract concept representing the level of confidence that an entity is who or what it claims to be and that it will behave in an expected manner. The desired level of confidence varies according to the consequences associated with a wrong decision.

Until the mid-19th century, tight-knit interpersonal relationships were the foundations on which trust, and the reputation that underpinned it, was built. Towards the end of the 19th century, formal systems of institutionalised trust such as banking, insurance, regulation and corporate brands, emerged as proxies for interpersonal trust.

Over the past five years we have seen institutional trust, in brands, leaders and entire systems, give way to trust built on transparent community marketplaces. This wave of digital marketplaces, popularised by organisations such as Airbnb and Uber, has taken the trust-by-proxy model to new levels. By developing and mastering a system of rewards and penalties, these digital marketplaces have enabled new types of transactions, often bypassing established supply

chains, that would have been unthinkable less than a decade ago. Billions of everyday online connections among people, businesses, devices and processes power the economic activity behind today's digital economy.

DIGITAL MARKETPLACES OFTEN BYPASS ESTABLISHED, TIGHTLY CONTROLLED, SUPPLY CHAINS

As decentralised supply chains evolve in response to an increasingly connected, digitalised marketplace, the institutionalised trust systems that underpinned much of the economic developments over the past century will also need to evolve to continue delivering value and remain relevant.

Digital marketplaces have enabled new types of transactions, often bypassing established supply chains

For example, currently end-users have a very limited view of the supply chains behind the products they purchase. Even the firms behind the end products have often been content with the limited information regarding the origins of the goods they source.



This lack of transparency became established as the norm, not because there is no demand for better transparency, but because historically, brands could maintain control with relative ease. Consequently, we have lacked the tools to retrieve independently verifiable information.

TRADE IN COUNTERFEIT AND PIRATED GOODS CONTINUES TO INCREASE

In a 2016 report¹ published jointly by the OECD and the European Union Intellectual Property Office, trade in counterfeit and pirated goods was estimated to amount to up to 2.5 % of world trade in 2013. The report also ascribes the increasing trade in counterfeit goods to an increasing use of small shipments by counterfeiters facilitated by the rise of online marketplaces.

Traditional methods relying on tight control of the supply chain and analogue forms of anti-counterfeiting are no longer sufficient as these can often be bypassed.

DIGITAL TRANSFORMATION OF SUPPLY CHAINS WILL BE KEY IN ENABLING NEW DEFENCES

The proliferation of track and trace solutions allows product status to be captured throughout the product's supply chain, enabling the product's origins to be retrospectively traced and verified. These solutions, introduced originally for inventory management purposes, are finding new applications by giving producers and distributors new ways to offer a transparent service, and therefore strengthen their brand trust.

The underlying technologies applied in each application offer varying degrees of sophistication² in line with the application needs. The common theme across these solutions is the ability to identify products in the supply chain down to the item level (rather than at the batch level).

THE ABILITY TO UNIQUELY IDENTIFY ASSETS WILL BE KEY TO THE SUPPLY CHAIN TRANSFORMATION

While the individual items do not necessarily need to be actively tracked down to individual level at all times, the

presence of a unique identifier allows items to be tracked by association e.g. as part of a lot number. As long as the pairing between the individual item and lot number level tracking is adequately secured (in line with the level of threat and risk that the product is exposed to), tracking can then be carried out at a coarse resolution throughout most of the supply chain.

Electronic Product Codes (EPC) introduced by GS1³ provide a globally unique identity that can be assigned to any physical object. In most instances, EPCs are encoded on RFID tags, but can also alternatively be encoded in printed format for optical decoding using linear, or two-dimensional bar codes.

In the pharmaceutical industry, a new mandatory method called "mass serialization" is becoming the worldwide standard for regulators⁴ as a tool to combat the increased proliferation of drug counterfeiting, illegal diversion and theft. For example, in September 2018, the US Food and Drug Administration issued draft guidance on what product identifiers must be incorporated into the drug supply chain to ensure product security and integrity. Mass serialization encodes each drug package with a unique identifier (including a unique serial number for each package), using a combination of alpha-numerical and machine-readable codes. These unique identifiers can be used to detect supply chain anomalies by checking for consistency against stored information collected during the product lifecycle.

Another important development is the harmonisation of traceability practices. In the electronics industry, the Association Connecting Electronics Industries, has recently created IPC-1782 – a new specification and standard for traceability practices across all levels of electronics manufacturing. IPC-1782 defines four levels of material and process traceability.

These levels, ranging from basic to comprehensive traceability, include increasing levels of traceability classified using five types of attributes: traceability resolution (e.g. work order, vs serialised item), data integrity (i.e. accuracy), level of automation, reporting lead time and data retention time. Most importantly, IPC-1782 specifies a hierarchical and extendible traceability data structure that can be adopted to harmonise traceability data collection across a supply chain. A similar framework could be applied and extended to other applications benefiting from harmonised traceability across the supply chain.

¹ OECD/EUIPO (2016), "Trade in Counterfeit and Pirated Goods: Mapping the Economic Impact, Illicit Trade" <https://doi.org/10.1787/9789264252653-en>.

² in terms of the level and frequency of tracking, attributes tracked and level of security offered

³ the non-profit organisation that develops and maintains supply chain standards including barcode formats

⁴ e.g. EU Falsified Medicines Directive and US Drug Supply Chain Security Act

DIGITAL TRANSFORMATION IN PHARMACEUTICAL SUPPLY CHAINS

The global pharmaceutical industry is one of the primary industries targeted by counterfeiters. To respond to these threats, pharmaceutical companies are at the forefront of adopting state-of-the-art defensive technologies. These include a combination of track and trace systems (TTS) and end-to-end product security features.

Various IoT-based technical solutions can be considered when building out a pharmaceutical TTS strategy. Systems that allow continuous, 24/7 monitoring of the critical physical parameters affecting temperature and photo sensitive drug products are key. When drugs are in transit from the manufacturer to the pharmacy or hospital they will often be transported by air or sea freight, rendering them potentially susceptible to extreme temperature fluctuations that must be monitored. As a result, any non-compliances must be flagged immediately to ensure product integrity and efficacy. Furthermore, products that are compromised in transit must be blocked from re-entering the supply chain.

This can be achieved using cloud-based technologies, such as sensors on packaging or containers that relay information in real time to the cloud via a variety of communication protocols (Bluetooth, wireless and cellular). The elements of these systems could also include chemical and electronic indicators⁵, GPS tracking of shipments, RFID tags, batch and dose level temperature control⁶.

Another way to protect the integrity of the drug is to provide secure, unique marking technology at both the package and dosing level. The marking technology can be placed within the wall of glass vials for parenteral products using a femtosecond laser.

Regardless of the types of sensors required for track and trace of the drug, these systems must provide a complete audit trail and traceability, should integrate with real-time alert management systems and include data access, control and management via web and mobile applications.

USING PROVENANCE TO EMPOWER CONSUMERS TO MAKE BETTER DECISIONS

Digital traceability and transparency of supply chain information across selected participants in the supply chain helps suppliers optimise their supply chains, often in ways that are not necessarily visible to the end customer.

By offering better access to verifiable provenance data, suppliers can empower end users to make better, more informed decisions about the products they buy, including environmental and social impact. This also introduces the opportunity for brands to re-connect with consumers by sharing distinctive product information.

By offering better access to verifiable provenance data, suppliers can empower end users to make better, more informed decisions about the products they buy

NFC tags⁷, multi-factor authentication codes⁸, and serialisation codes⁹ enable the collection of varying degrees of verifiable information related to the product's authenticity, safety, environmental and social impact of the product's life cycle. Unique product identities can function as a digital gateway for offline products, enabling suppliers to open up their products' supply chain and origin stories to potential buyers. This, in turn, empowers consumers to make better decisions, enabling responsible suppliers to differentiate through verifiable information related to the product's safety, environmental and social impact.

Provenance has traditionally been associated with place of origin, for example using protected designation of origin (PDO) or protected geographical indication (PGI). Brands have been used as a proxy for a broader form of provenance, one that encompasses characteristics such as quality, ethics and environmental and social values.

Goods that carry a provenance pedigree are rarer and therefore often available at a premium. As counterfeiters continue to

take advantage of weaknesses in supply chains¹⁰, consumers increasingly demand to know more about the history of the products they buy, particularly if they are paying a price premium attached to product provenance. Organisations that are unable to share information about their supply chains, and allow customers to verify their claims, will see their ability to charge a premium erode over time.

...consumers increasingly demand to know more about the history of the products they buy

Inevitably, there will be different levels of interest across types of goods and some user groups tend to take a lead. Programmes such as Fairtrade and organic movements have however shown that what might start as a fringe movement can reach a critical mass and become mainstream.

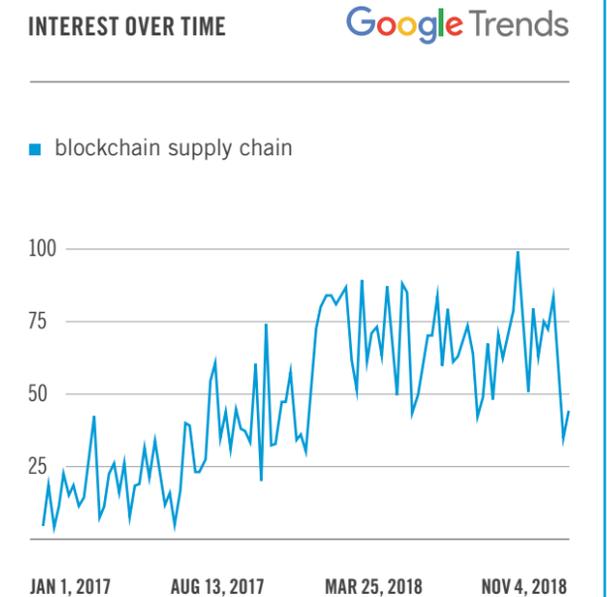
Yet, for much of today's goods, consumers have had to rely on printed labels on product packaging as an indicator of provenance. This reduces the value of the provenance, as the information is hard to verify and for many users the actual meaning is also difficult to interpret and relate to.

Companies such as Provenance¹¹, a UK-based start-up, are pioneering the latest technology platforms to allow suppliers to actively share the product's journey and its environmental and societal impact with their customers.



BLOCKCHAINS STILL NEED TO DEMONSTRATE UNIQUE VALUE IN SUPPLY CHAINS

Blockchains are at the peak of Gartner' 2018 hype cycle for supply chain strategy. It is therefore no surprise that the number of blockchain related pilots, investments and announcements associated with supply chain continued to grow during 2018.



For supply chains relying on participants that are not known or trusted, either directly or through a trusted third party, blockchains can facilitate collaboration based on independently verifiable cryptographic trust, built using devolved consensus.

Yet, to date, no applications demonstrating the technology's unique value within supply chains have gained widespread adoption. To realise their true potential, blockchain applications in supply chains will need to capture independently verifiable inputs from a large number of parties that do not have access to an alternative trust source. Many applications have failed to deliver on at least one of these criteria, and therefore fail to deliver distinctive benefits that could not be more easily realised using traditional ledgers.

⁵ temperature, humidity, CO2, pulse, light, voltage, current,...

⁶ several specialist organisations such as Wessex Power, Oceosoft, Roambee and Cognizant already provide solutions in this space

⁷ see for example: <https://www.thinfilmmfc.com/>, <https://www.smartrac-group.com/>, and <https://www.nxp.com/docs/en/brochure/make-your-products-smarter-with-RFID-NFC.pdf>

⁸ see for example: <https://www.certilogo.com/>

⁹ see for example: <https://www.respect-code.org/>

¹⁰ In a 2015 report, NetNames estimated the annual cost of counterfeiting to be at USD 1.8 trillion globally, or 2% of the global economic output, with online distribution growing by over 15% p.a. <http://www.netnames.domains/insights/whitepapers/2016/counting-the-cost-of-counterfeiting/>

¹¹ <https://www.provenance.org/>

DIGITAL TRUST SYSTEMS WILL PLAY A CRITICAL ROLE IN ENABLING NEW SUPPLY CHAIN BUSINESS MODELS AND VALUE CHAINS

OVER THE NEXT DECADE, SUPPLY CHAINS WILL RE-SHAPE... FROM:	TO:	THESE TRANSITIONS WILL CREATE NEW VALUE CHAINS... WITH OPPORTUNITIES FOR:		DRIVEN BY:		IN ORDER TO SUCCEED, EARLY ADOPTERS SHOULD:	WIDE-SCALE ADOPTION WILL BE ENABLED BY:
Networks of tightly controlled suppliers relying exclusively on institutionalised trust	Dynamic systems, increasingly reliant on new business models supported by digital trust systems	<ul style="list-style-type: none"> Suppliers to use product provenance as a value-add tool and to empower users to make better purchasing decisions 	<ul style="list-style-type: none"> Suppliers to respond to the rising levels of counterfeit goods 	<ul style="list-style-type: none"> Non-incumbent supply and distribution networks to offer services in environments where new entrants traditionally faced high entry barriers 	<ul style="list-style-type: none"> Need for better transparency, particularly in the context of digital marketplaces Rising trade in digital marketplaces including resale of used goods and sale of excess merchandise Growing security risks associated with digital/connected products whose integrity may have been compromised in the supply chain Rising levels of counterfeit goods and end-user awareness Brands need to protect their quality, ethical, environmental and social values Competitive forces challenging the status quo 	<ul style="list-style-type: none"> Exploit back-end analytics that can spot supply chain anomalies without relying on perfect data in-feeds Focus on applications that do not rely on other players (unless part of a consortium) in the supply chain to adopt new technologies or processes 	<ul style="list-style-type: none"> Rising adoption of digital track-and-trace technologies driven by lowering cost and offered efficiency gains Proliferation of unique product identities, that can be read using consumer smartphones Increased capabilities fuelled by improved data sources such as cryptographically secure identities for physical goods Platforms that automate low-level compliance checks particularly those where active end-user intervention would otherwise be required Rapid developments in digital trust systems enabling increasingly robust independently verifiable transparency that is no longer dependent on institutionalised trust Consolidation of competing/incompatible emerging digital trust systems such as distributed ledger technologies and blockchains, and more widespread adoption of sensor/tagging technologies

DIGITAL TRANSFORMATION ENABLES SUPPLIERS TO RESPOND MORE DIRECTLY TO CUSTOMER DEMAND

SUPPLY HAS TRADITIONALLY BEEN BUILT BASED ON UNCERTAIN DEMAND FORECASTS

Traditional supply chains place product development companies in control of what flows through the supply chain: planning new product offerings, sourcing components, overseeing manufacturing, and finally distributing products for retail. In this model, customers order products by choosing among available offerings as pre-determined at the top of the supply chain. Meanwhile, product development companies and other organisations in the supply chain rely on forecasts in an attempt to manage the risks associated with how many of a particular product will sell, where and when.

POSTPONEMENT STRATEGIES ALLOW SUPPLIERS TO RESPOND MORE EFFECTIVELY TO UNCERTAIN DEMAND

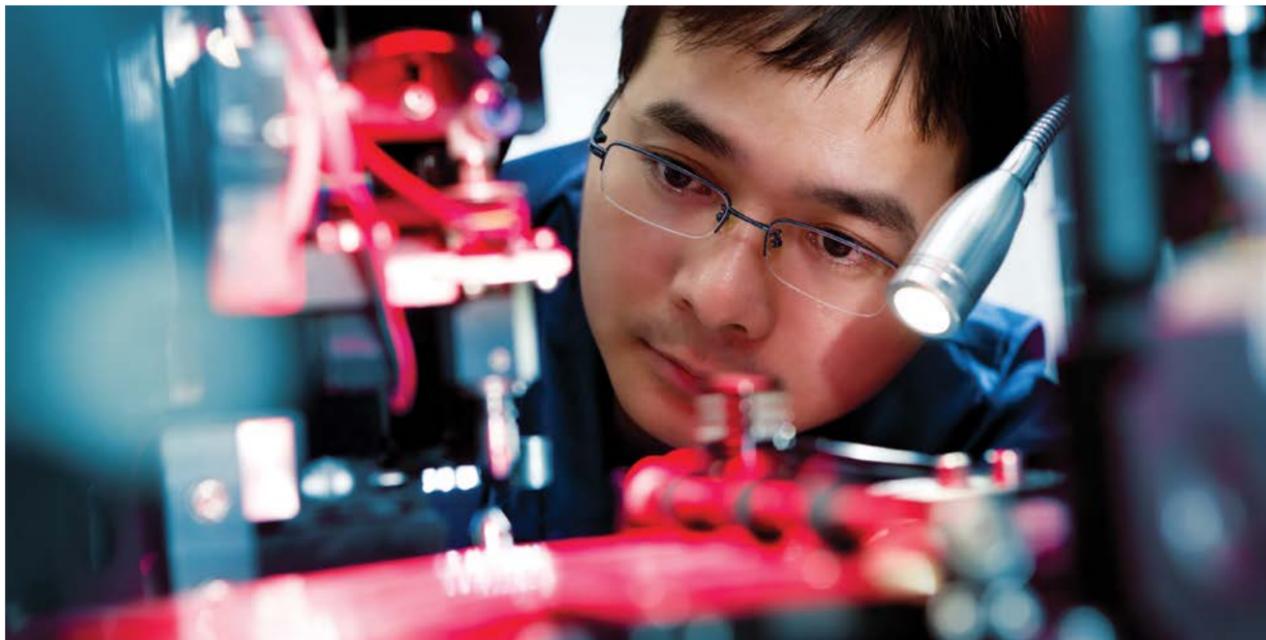
Demand forecasting is inherently inaccurate, leading to supply chain inefficiencies due to mismatch in supply and demand. To counter this, organisations can choose to defer some operations and decisions to later stages in the supply

chain, when and where more accurate information about what customers in specific locations want becomes available. This deliberate choice to postpone specific operations and decisions to later stages in the supply chain, closer to the demand triggers is often known as postponement strategy.

A classic example of this postponement strategy is Dell Computers' build-to-order approach for Personal Computers in the 1990's. Dell Computers created a competitive advantage, offering a highly-customisable Personal Computer product range, by adopting a postponement strategy based on the assembly of the product in response to customer demand, rather than focusing on inventory management as required by the more conventional mass production approach.

ONLINE RETAIL HAS ALREADY CREATED NEW POSTPONEMENT OPPORTUNITIES

The e-commerce retail model benefits from exploiting another form of postponement, known as location postponement. Virtual inventories allow online retailers to offer a broad variety of merchandise independent from the physical location of the inventories at the time orders are



placed. These organisations thus improve their operational efficiency through improvements in customer service, without increasing inventory carrying costs. This is made possible by postponing the location of inventory to their suppliers in the upstream supply chain until the arrival of customer orders.

Virtual inventories allow online retailers to offer a broad variety of merchandise independent from the physical location

For over 10 years, Amazon has offered a print-on-demand service that enables print publishers to fulfil customer demand without having to hold any inventory. Through its central role as part of the demand chain, Amazon can adopt an appropriate postponement strategy by creating a supply only in response to actual customer needs.

POSTPONEMENT MODELS ARE SET TO BECOME MORE COMMONPLACE

Postponement strategies, where supply is triggered with a customer order, are particularly attractive for products that are subject to unpredictable and/or highly variable demand or those that benefit from a high degree of customisation.

Additive manufacturing, which includes 3D printing, is rapidly expanding in both technical capabilities (faster, lower cost, more reliable, more versatile use of materials and better finish) and its growing supplier ecosystem. As a result, it is emerging as an attractive production method for a broader range of objects, including custom medical implants, footwear insoles, jewellery, toy articles and aerospace parts.

The impact of additive manufacturing on traditional supply chains have often been highly overstated. Some have extrapolated today's capabilities to anticipate the demise of mass production and the rise of manufacturing inshoring. While such wide-scale revolutions will be unrealistic in the short term, the implications of mass customisation and enabling technologies such as additive manufacturing will be transformational to specific industries whose needs cross over with the offered technical capabilities. For example, in 2017, Materialise, a provider of additive manufacturing solutions, partnered with winter sports gear and tailored

footwear specialist Tailored Fits, to launch the world's first end-to-end digital supply chain for custom-fit ski boots.

DIGITAL TRANSFORMATION ENABLES SUPPLIERS TO RESPOND DIRECTLY TO CUSTOMER DEMAND

As the above example and other innovations such as the Amazon Dash button illustrate, the transition to a digital supply chain enables suppliers to become more responsive to end-user demand. Likewise, with the increased proliferation of connectivity, suppliers no longer have to rely solely on information working all the way back from the various points of sale for them to understand and respond to end-user demand.

Digital supply chain enables suppliers to become more responsive to end-user demand

The long delays and many steps involved between supply and demand triggers in traditional supply chains cause imbalances in supply and demand. Technologies underpinning the digital transformation can improve the information flow between demand and supply. However, direct access to demand triggers from end users is often a question of business model and an organisation's role in the product value chain. Technology alone is not a sufficient enabler unless the organisation in question (a component supplier, for instance) has access to the relevant information. To benefit from these opportunities, organisations need to focus more on finding ways to improve access to demand triggers, either by establishing direct channels with end users, or forming alliances with other players in the supply chain.

To benefit from these opportunities, organisations need to focus more on finding ways to improve access to demand triggers

DEMAND FULFILMENT BASED ON RESPONSIVE DIGITAL SUPPLY WILL COMPLEMENT PHYSICAL INVENTORIES BASED ON TRADITIONAL DEMAND FORECASTING

OVER THE NEXT DECADE, SUPPLY CHAINS WILL RE-SHAPE... FROM:	TO:	THESE TRANSITIONS WILL CREATE NEW VALUE CHAINS... WITH OPPORTUNITIES FOR:		DRIVEN BY:		IN ORDER TO SUCCEED, EARLY ADOPTERS SHOULD:	WIDE-SCALE ADOPTION WILL BE ENABLED BY:
Supplying based on physical inventories of finished goods	Closed-loop supply-demand systems with physical inventories of finished goods increasingly complemented by virtual inventories of customisable goods and components	<ul style="list-style-type: none"> Players down the supply chain to create more value-add by offering postponement services to players higher up in the supply chain Suppliers of customisable goods to offer higher degrees of product customisation without compromising supply chain efficiencies Retailers to become part of the customisation process, particularly for products that require specialist equipment to create the customisation experience Better and faster response to unpredictable customer demand and needs 	<ul style="list-style-type: none"> The rise of digital marketplaces of customisable goods New manufacturing technologies, in particular, additive manufacturing Expansion of app marketplaces to an increasing range of devices beyond traditional smartphones (vehicles, wearables, home appliances, digital cameras, personal health devices etc.) Additive manufacturing and its growing supplier ecosystem 	<ul style="list-style-type: none"> Consider postponement services as a service complementing rather than only as a replacement for mass production and the associated traditional supply chains Where possible, use digital technologies to create a demand channel directly from the customer. Use this as inputs to supply and where possible, customisation and design Consider forming alliances with other players in the digital supply chain to improve access to end-user needs and requirements where these are not readily available directly higher up in the chain 	<ul style="list-style-type: none"> Expanding technical capabilities of additive manufacturing and its growing supplier ecosystem Increased adoption of servitisation strategies Ubiquitous connectivity Over-the-air software updates (including “app marketplaces”), enabling remote upgrades for an increasing range of connected products 		

CONCLUSIONS

New technologies are redefining customer expectations and the ways in which businesses fulfil these changing expectations. People, businesses and processes are increasingly interconnected, and these interconnections do not always follow previously established routes.

As decentralised supply chains evolve in response to an increasingly connected, digitalised marketplace, the institutionalised trust systems that underpinned much of the economic development over the past century will also need to evolve to remain relevant. Digital trust systems are fuelling the evolution from institutionalised trust, to trust built on independently verifiable transparency. To retain brand equity derived from characteristics such as authenticity, ethics and environmental and social values, organisations need to harness the capabilities of emerging digital trust systems, enabling end-users to build trust based on independently verifiable transparency.

Adoption of track and trace technologies continues to grow, driven by supply chain efficiency gains. An increasing amount of information is being captured in relation to the products we use. By selectively opening up these information sources and making them accessible to, and independently verifiable by, end users, responsible suppliers can differentiate by building origin stories related to the product's authenticity, provenance, safety, environmental and social impact.

Meanwhile, digital transformation will also enable supply chains to become more responsive to end-user demand. Advances in postponement technologies, demand-driven supply chains and associated business models will continue

to generate opportunities for players at various stages of the supply chain. These opportunities include supply chain efficiency gains and value-add by creating new ways to serve customers' need for convenience and increasing levels of customisation.

Efficient supply chains are the result of a balanced supply and demand. Efforts in supply chain improvements have typically been equivalent to optimising an open loop process. The long delays and many steps involved between supply and demand triggers in many supply chains, cause optimisation barriers. The digital transformation of supply chains will create opportunities for suppliers to respond directly to customer demand, thereby creating a closed loop process that initiates with an end-user demand trigger. To benefit from these opportunities, many organisations will need to consider forming alliances with other players in the digital supply chain.

In conclusion, digital trust systems, demand-driven supply chains and postponement methods will not entirely replace established trust models and established manufacturing and distribution methods. They will however create opportunities for established and emerging organisations to take part in new value chains that will complement, and in some instances replace, established value chains.

With rapid advancement in the technologies underpinning the transitions covered in this report, there has never been a better opportunity for new players and established organisations to build transparent, demand-driven supply chains and powerful trust relationships with end users.



About Cambridge Consultants

Cambridge Consultants is a world-class supplier of innovative product development engineering and technology consulting. We work with companies globally to help them manage the business impact of the changing technology landscape.

With a team of more than 800 staff in the UK, the USA, Singapore and Japan, we have all the in-house skills needed to help you – from creating innovative concepts right the way through to taking your product into manufacturing. Most of our projects deliver prototype hardware or software and trials production batches. Equally, our technology consultants can help you to maximise your product portfolio and technology roadmap.

We're not content just to create 'me-too' products that make incremental change; we specialise in helping companies achieve the seemingly impossible. We work with some of the world's largest blue-chip companies as well as with some of the smallest, innovative start-ups that want to change the status quo fast.

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