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**Fostering Digital Marketplaces in Logistics and Supply Chain: Trends
and Opportunities**



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To my beloved mother

ABSTRACT

Technology disruption can occur in a sector where the incumbent players are failing to develop solutions to address industry inefficiency. Despite its significant economical aspect and growth globally, the logistics industry still faces with several challenges such as tracking, complex regulations, demand-supply mismatches, lack of trust and transparency, volatile rates and more other relevant issues because of its highly fragmented nature. In the current traditional method, shippers rely on third party logistics providers such as freight forwarder or brokers to reach carriers to deliver their goods, while carriers are forcibly depending on brokers to find more loads and reduce their dead hauls in return of a commission. With the rise of digitalization and on-demand platforms, the concept of logistics marketplaces has been adapted also in the industry. The logistics marketplaces connect shippers and carriers more quickly and efficiently, helping carriers maximize their productivity and asset utilization, resulting in lower costs for shippers. However, these arrangements also mitigated the main issues in the logistics industry to a certain point. This study aims to investigate how to create differentiated freight marketplaces, geographically focused in North America, while some particular insights are given on the disruptive technologies such as Blockchain, IoT and sensors.

1 INTRODUCTION

The logistics industry is known as highly fragmented and significantly large ecosystem. A fragmented industry means an industry where many companies compete and there is no single or small group of companies which dominate the industry. The competitive structure of this kind of industry does not let any company to have overly strong or influential position in the industry. As a consequence, the fragmented industries are highly appealing for strategic disruptors. Michael Porter states in his book [1]:

“Overcoming fragmentation can be a very significant strategic opportunity. The payoff to consolidating a fragmented industry can be high because the costs of entry into it are by definition low, and there tend to be small and relatively weak competitors who offer little threat of retaliation.”

For instance, the top fifty trucking companies in the US handle only thirty per cent of the total freight activity and one in nine American truckers is an independent owner-operator rather than an employee. Accordingly, many segments in logistics industry are commoditized with low barriers to entry which leads it to be typified by low margins and high competition [2].

Many companies prefer outsourcing non-core activities from third-party providers in order to take advantage of greater operational flexibility. Outsourced logistics services are commonly contract logistics, freight forwarding and transportation. Therefore, most of the shippers have traditionally relied on intermediary parties such as forwarders or brokers to find the most convenient carrier option to deliver their goods to ease their transportation processes. Meanwhile, carriers have also trusted them to find loads and reduce their dead hauls, as well as to prevent selling their loading capacity at low prices due to lack of accurate demand forecasts

1.1 Freight Transportation Intermediaries

In this sub-section, freight transportation intermediaries will be introduced to better understand the current problems in logistics, rising from the dynamics with third party providers. Traditional transportation intermediaries can be broadly categorized as brokers, forwarders or third-party providers.

1.1.1 Freight Forwarders

When it comes to arrange the shipments of their goods, companies contact with a freight forwarder who is responsible for the logistics of moving goods, however, don't typically own their equipment and instead have established relationships with many carriers, couriers and airlines owing significant network capabilities.[3] Freight forwarders are fully liable for delivery of the freight and must produce all the necessary documents from custom forms to their own bill of lading while offering services essential to shipping such as assembly, consolidation, and distribution of items.

A freight forwarder can arrange freight transportation in any mode (rail, air, ocean, and motor). Freight forwarders can contract out a part of their shipping process by seeking out the services of a freight broker if there is a necessity for motor carrier transport services. In short, a freight forwarder can:

- carry out partially or completely the transportation through its own fleet of vehicles;
- provide storage in their own warehouses;
- provide the customs documentation;
- be in charge with fiscal matters;
- procuring and offering insurance for the goods;
- assistance in packaging the products.

1.1.2 Freight Brokers

The role of a freight broker is to match the demand of buyers with the seller of freight services. Freight brokers, known as gatekeepers of the industry, are legally authorized to act as an agent on the behalf of shippers and carriers. They typically charge high middle-man commissions, sometimes up to 30%, for their activities of making freight easier to manage, that is in actually increasing the cost of freight and decreasing what asset owner carriers earn.

The main difference between freight forwarder and freight broker is the latter does not own a fleet of vehicles and outsources all the logistics activities. Since brokers do not physically handle the freight shipment, they do not need to provide a bill of lading. Freight brokers are typically not liable for cargo loss or damage, unless stated in the contract, however many brokers offer liability coverage and they can arrange for freight transportation only by motor carrier.

Large brokers such as CH Robinson and XPO Logistics are examples of freight broker companies that also have freight forwarding capabilities and their own carrier base.

1.1.3 Third party logistics provider (3PL)

Third party logistics companies provide a wide range of services including inventory storage and management, picking and packing, freight forwarding, shipping/distribution, customs brokerage, contract management and IT solutions. They are typified high degree of integration with the operations of customers. The largest 3PL companies in the US are Penske Logistics and Schneider Logistics.

1.1.4 Problems in Logistics Industry

Since decades, shippers are facing several problems arising from having the need of such traditional intermediaries. First of all, brokers make hundreds of phone calls before finding the right carrier with available trucks best matching with the requests of shippers.

This time that brokers spend manually coordinating results in more time shippers spend waiting to know whether their loads will be covered.

Freight forwarders are also reliant on time consuming email and telephone communications to contact carriers in order to get most convenient quotations and bookings. In addition, the traditional way of managing and storing information also prolongs the process. Many companies still use paper-based methods to record important transactions that can be easily modified and therefore become unreliable.

Trust is a highly limited commodity due to the high level of fragmentation in the industry. The lack of trust is likely to create a scarcity of another valuable aspect which is transparency. Brokers typically charge a commission of 15 to 20%, and with the lack of transparency into the process, brokers can choose the priciest options for their clients to increase their mark-up. A traditional broker's capability to match the right carrier supply with shipper at optimal price is limited by the number of trucks in the broker's individual network. This inevitable over-reliance on intermediaries has brought an element of opaqueness to the operations in every single value chain of the business since there is no direct communication between the primary parties.

Additionally, existing monitoring systems such as the Global Positioning System (GPS) and the Electronic Data Interchange (EDI), have been very beneficial to the industry; however, their impact is still limited and there is still the need of further technologies to be scaled up.

1.2 Trucking Industry in North America

In this section, the road freight market in North America, focusing on trucking industry, has been taken as reference to explain further marketplace features due to the complexity of other types of transportation models in the industry. This will also benefit to understand the passage from simple digital load board platforms like DAT to technologically enabled SaaS cloud-computing services.

The North American road freight market size is estimated to grow by USD 94.7 billion [4] and almost 70% of the freight transportation is executed by trucks. The North American trucking industry consists of 8.6 million medium-heavy vehicles in operation and 19.6 million light duty trucks Vehicle in Operations.

The United States (US) trucking industry is facing with major challenges, such as stringent environmental regulations, oil price fluctuations, freight demand fluctuations, low operating margins and operational inefficiencies.

Two core shipping methods in trucking industry should be explained before going into the details of this chapter. First of all, Full-truckload (FTL) shipping which is used when one company fills up an entire truck space with product. In FTL shipping, there is a single destination as no other company's product in transport. Secondly, Less-than-truckload shipping is a way to share the space on a truck in order to meet the requirement of filling the entire space of trucks before the shipment. A company that does not have enough of a load to use the full capacity of a truck benefits most from LTL-shipping. It is known as FTL operations are generally more efficient than LTL services amid competitive pressures.

After these explanations, we can say the capacity utilization seems to be one of the greatest challenges, since it is up to just 79% full truckload (FTL) operations and 68% capacity in less than truckload (LTL). Thus, 21% of the capacity in a truck destined to carry an FTL remains empty while the situation is even worse in the case of LTL operations, on average, with 32% of capacity left empty per ride. Under-utilized capacity results in inflated costs for carriers, which in turn is passed on to shippers and end consumers.

The US freight brokerage industry is highly fragmented in terms of shippers, carriers, as well as intermediaries such as brokers. To highlight the level of fragmentation, it should be considered that the largest brokerage entity captures for less than 6% of the entire freight brokerage market.[5]

Reducing empty miles and improving route efficiency could mitigate challenges such as driver shortages and seasonal fluctuations in freight rates. This empty miles problem,

arising primarily due to again the fragmentation of the industry and the lack of direct communication with no transparency, together with the fluctuations of fuel costs results in volatile rates in the industry.

Moreover, empty miles have an enormous environmental impact, wherein more emissions per ton of freight transported are entering the air than necessary. The environmental issues posed by the burning of fuel and the growing concerns over the matter have only increased the intensity of the regulations and escalated the compliance costs to exorbitant levels. Due to emerging regulations such as Greenhouse Gases regulations, enabler technology will be required be added to vehicles, which will result in more expensive trucks for fleet customers. Thus, any possible cost-effective solutions to reduce empty miles would impact drastically the entire trucking ecosystem.

Meanwhile, the emergence of the 'delivery within 48 hours' promise has increased the stress on the freight industry. Quick delivery has become a key differentiator between competitors in the e-commerce. However, companies that manage private trucks have to operate with increasing efficiencies and compliance to authority while meeting customers' growing expectations for just-in-time delivery with competitive pricing, all the while working to safeguard profit margins. That is why truckers often take charge of more than what they could deliver on time; the ensuing delivery pressure and subsequent delays both fuel each other.

To conclude, the global logistics industry is highly fragmented with shipments worth billions of dollars moving across many routes. It is impossible to track shipments accurately with the scale and complexity of freight transport. Supply chain managers are wasting significant time and energy seeking to recover inefficiencies in the supply chain, which can be highly challenging to accomplish without sufficient exposure in supply chain. Furthermore, fraud and theft are significant issues for logistics companies incurring massive investments. Companies need verified and secure data to successfully carry out their business operations and plan for the future activities.

The mentioned problems and inefficiencies in the logistics industry are explained in order to demonstrate the need of disruptive innovations to integrate in the industry within digital era. This is the reason why each day more start-ups are inventing solutions to address

these problems, pioneering digital platforms to better match shippers and carriers to maximize capacity utilization while both decreasing deadhead miles and accelerate shipping times. For instance, trucking apps and load boards, which will be discussed in detail in the later chapters, are developed by new entrants aiming at solving the problems of freight mobility, freight optimization, and driver utility.

1.3 The rise of digitalization

Digitalization has become one of the most significant factors that intensifies the competition in almost every industry. Earlier, information technologies were mainly considered as a tool to support several internal functions such as inventory management. Shortly after, business processes became more digitalized in order to achieve better efficiencies and cost savings, embracing applications customer relationship management (CRM) and enterprise resource planning (ERP) within companies. Nowadays, IT capabilities are exploited for the differentiation purposes to gain competitive advantages by creating new products/services as well as innovative business models like sharing economy.

The sharing economy has the potential of disintermediation within the collaboration of using the excess capacities which results in increased productivity. Barnes and Matsson describe collaborative consumption as “the use of online marketplaces and social networking technologies to facilitate peer-to-peer sharing of resources (such as space, money, goods, skills and services) between individuals who may be both suppliers and consumers.” [6]

Digitalizing the entire logistics process of tendering, contracting, delivering, and payments within online marketplaces enables logistics providers to participate actively, ensuring their services remain price competitive and highly flexible.

Digital marketplaces fall into three types of logistics services which are shortly describes below.

- 1) Freight marketplaces offer better comparability and transparency of proposals with optimal price/performance ratios to the customers. Logistics providers can

use these platforms to digitalize their internal activities as well as increase their utilized capacity.

- 2) Warehousing marketplaces provides on-demand warehouse space within automated quote comparison features in order to improve time consuming and less flexible processes of long-term contracts.
- 3) Last mile delivery marketplaces are developed because of the growing demand for on same day/ same-hour pick-up services. Customer can receive auction-style bids from private individual participants acting as on-demand delivery agents, compare quotes and simply book. However, these platforms require a critical mass of individuals to participate to ensure a sustainable business model in order to prevent the situations like the shutdown of UberRush.

Digital freight marketplace segment, that is the main focus of this thesis, is explored explicitly in the following chapters.

1.4 Outline of this thesis

The aim of this thesis is to explore the promising impacts of digitalization and Logistics 4.0 paradigms in the logistics industry within the emerging sharing economy model. In **Chapter 2** where the theoretical background on electronic logistics marketplaces are explained. Meanwhile, in **Chapter 3** the key drivers of the rise of digital freight marketplaces are discussed. Moreover, **Chapter 4** is exploring the all types of marketplace models providing case studies of existing companies. In following, **Chapter 5** explains why leveraging disruptive technologies would help overcome obstacles in current marketplaces. The last chapter is exploring the blockchain integration into centralized marketplaces and the possible outcomes of such disruption.

2 LITERATURE REVIEW

Online marketplaces are digital platforms where transportation capacity is shared, offering both short term (spot market) and long-term contracts with additional value-added services for supply chain management purposes.

2.1 Electronic Logistics Marketplaces

The main goal of ELMs is to improve the information flow between the three parties involved in a shipment – the shipper, the transport company and the customer – through the use of information and communication technology (ICT) by providing them low cost means. They consist of a range of collaborative approaches to render the movements of freight more efficient and sustainable. An open collaboration is where participants are freely collaborated without having formal entry requirements while a closed ICT platform membership is only available to those who are invited to collaborate.

The development of the marketplace is usually led by one organisation which is usually the shipper however could be the carrier, customer or technology provider. A wide range of functions can be incorporated into an ELM. [8]

These include:

- *Transport planning* – although this activity normally takes place outside of the ELM, this may not always be the case.
- *Communication* – passing information between the shipper, transport operator and customer. Information includes the allocation and acceptance of loads.
- *Tracing and tracking* - monitoring and controlling the progress of shipments once they have been despatched.
- *Invoicing* – by having data available on which loads were transported and by whom, it is possible to automate the invoicing process between the transport provider and shipper.
- *Performance reporting* – using the data captured within the ELM to generate a range of performance reports.

2.2 Types of electronic logistic marketplaces

The electronic marketplaces can be broadly categorized within the following ways depending on the services they provide; clearinghouse (load boards), auction houses and freight exchanges.

Carriers and shippers indicate their requirements, and carriers post their unfilled /unutilized capacity in a load board. These portals are based on database of loads posted by the registered shippers (or brokers) and carriers (or 3PLs) who utilize, furthermore, the inserted information for negotiations. [9] The access to the platform is also accessible through wireless devices that transmits EDI and XML based data.

In an auction houses, transportation capacity in sport market or demands in longer-term contracts are auctioned between shippers, carriers,3PLs and freight forwarders. On the other hand, such participants post the demand and capacity in a transportation exchange similar to auction houses, however the marketplace matches automatically at competitive price.

The market places can be also characterized as open, private and collaborative depending on the level of limitations of carriers who interest in participate to the platform. [10]

1.) Private ELMs: When the leader in the logistics sector develops its own ELM and invites other parties to join into this system, it is called private electronic logistic marketplace. Under this structure, the company is totally responsible for its operations and the information flows through the platform. This type of platform is an only place where one shipper to several carriers, while there is no collaboration with any other ELMs, which renders it a marketplace to optimize one company's network. Consequently, a private ELM becomes a central point of linear communication between its own network. This aspect of such ELM makes it easier to add extra business while relative high cost disadvantages are risen up especially in terms of creating an interface between each partner company's system and the ELM.

- 2.) *Open ELMs*: The only difference between private and open, also known as shared structures is the fact that information can be communicated between the different ELMs in the latter case. All other ELMs are hosted by a single organization and share the same platform. Under this structure, a high degree of process coordination is offered through unique marketplace while easier transactions are enabled between each stakeholder.
- 3.) *Collaborative ELMs*: Collaborative ELMs, as it can be presumed by its name, are based on a collaboration between several organization who are aligned through common interests. They set up synergies within product flows and try to profit the capacity of carries as much as possible. Because multiple supply chains are involved, there is a requirement for a high level of integration between shipper and carrier, which in turn implies a high degree of “open book” collaboration based on commercially sensitive data. The significant value of this type of structure is being highly customized to the needs of the community thanks to its horizontal collaboration between shippers as well as the vertical collaboration between shipper and carriers. An advantage of the collaborative platforms is its capability to reduce complexity of the marketplace software by having a common system across different supply chains. In addition, the structure renders it possible to optimize the supply chain flows to minimize the distance vehicles cover by providing extensive visibility of freight movements across multiple ones. On the other hand, the investment required in ECT infrastructure in a more efficient way might be considered as a disadvantage, especially when specific functions such as real time tracking is deployed.

2.3 Benefits

ELMs increase the visibility of the shipment to the shipper, carrier and customer as it progresses through the supply chain by enabling information flows to be simplified and automated. This also gives a rise to additional benefits such as lower costs, greater productivity, increased security for shipments, shorter lead times and a reduction in disputes and litigation.

The main requirement of extensive usage of the Internet for ELMs does not necessarily mean that transport companies need high levels of technological implementations. Because ELMs are ICT systems that link simple shippers, carriers and customers together for the purpose of information sharing and long-term collaborative while involving pre-defined contracts and rates. ELMs can be constructed in house or hosted by a third party.

If we have to discuss the benefits for each party involved to these platforms; for shipper ELMs are a platform that helps them to gain better visibility of all consignments regardless of which carrier does the deliveries. It leads to more reliable delivery and an improved customer service level, as well as better management of carriers' performance. In addition, carriers will enjoy achieving better fleet and labor utilization through better scheduling and be more responsive to shippers' requests through improved visibility. Affordable ICT infrastructures lower drastically the perceived entry barriers and smaller carriers can now compete successfully with larger ones. On the other hand, tracking and tracing functions are provided through the platforms which also lead to greater confidence in both the shipper and the carrier.

The use of an ELM is largely driven by the business needs and company strategy. However, there are also external factors that can drive companies to adopt ELM technology at macro level:

- Political factors: global trading lengthening supply chains
- Environmental factors: CO2 emissions and congestion leading to pressure to reduce transport
- Societal factors: local delivery constraints affecting efficiency
- Technological factors: growth in Web and wireless technologies, as well as the software as service concept making it easier to share information
- Economic factors: reduction of empty running, efficient fleet management, visibility of delivery information for quick and proactive decision making, and improved customer service

The development of the marketplace is usually led by one organisation which is usually the shipper however could be the carrier, customer or technology provider. A wide range of functions can be incorporated into an ELM.

3 DIGITALIZATION IN LOGISTICS INDUSTRY

Technology disruption can occur in a sector where the incumbent players are failing to develop solutions to address industry inefficiency.[11] In an industry like logistics that is suffering from significant inefficiencies, the digital revolutions are much needed, not only because of the urgent market needs or the potential opportunities to be exploited by the new entrants, but also because of the positive environmental impacts such as efficient energy consumptions.

3.1 Logistics 4.0

The Fourth Industrial Revolution is the term to describe transformation of economies by the convergence of breakthrough technologies – such as advanced robotics, artificial intelligence, the internet of things, virtual and augmented reality, wearables and additive manufacturing – that are also changing productions processes and business models across different industries. [12] According to the analysis of World Economic Forum, the effects of 4IR have the most impact in the development of the transport, logistics and supply chain industry in which it is expected to have \$1.5 trillion of value at stake for the stakeholders and further \$2.4 trillion worth of societal benefits by 2025 as a result.

The inevitable diffusion of digitization is leading to a new paradigm called “Logistics 4.0” which is based on four key digital trends:[13]

1. *Data automation and transparency.* Data has always been important impacts on logistics, and new improvements in data collection and analysis offer the opportunity for companies to better meet their goals by optimising their resource management process and route networks. This trend enables real-time tracking capabilities aimed at achieving transparency of supply chain.

Leading logistics providers have been working on optimising these indicated problems for years, and today technology allows increasingly accurate forecasts of necessary capacity, personnel time, operating expenses and other requirements. Additionally, real-time, shareable and transparent data provides the ability to

introduce other disruptive technologies such as omniscient control towers (delivering end to-end visibility over the supply chain), artificial intelligence and augmented reality.

2. *New methods of physical transportation.* Autonomous vehicles, advanced robots and drones are providing economical gains to the companies who have implemented them. The successful implementation of these technologies gives rise of new considerations such as employment, control and liability.
3. *Digital platforms.* Online logistics platforms such as marketplaces, digital freight forwarders and load boards present the biggest disruption in sector within the development of ‘sharing economy ‘capabilities. These platforms enable capex-free actors to be involved in the ecosystem and introduce new business-models’ opportunities. Sharing economy and shared logistics capabilities concepts will be discussed in the next subsection.
4. *New production method.* 3D printing and additive manufacturing solutions can affect traditional logistics industry by allowing new decentralized business models. For instance, the need of shipping particular goods might be replaced by on site 3D printing. This way an opportunity for contract logistics to integrate this kind of technology into their offerings while differentiating with last-mile customization.

Digital transformations showed platform-operated entities such as UBER and Airbnb to be digital disruptors. Like in many other sectors, digital platforms dis-intermediate entire industry, and digital innovations can help logistics players improve efficiency and lower costs, as well as develop new business opportunities.

3.2 Sharing Economy Model

Sharing economy is a radically competitive paradigm for a variety of sectors that are of strong resources type, such as mobility and hospitality.[14] However, same digital solutions and business models enabling this model can be applied to the logistics industry

along with its heavy assets and infrastructure. There are many reasonable factors that suggest sharing could be well suited to increasingly incorporate into the logistics industry.

First of all, requirements put on logistics providers to reduce cost could partially meet thanks to increased freight sharing. Consequently, efficiencies and productivity gains in the process would be increased. Meanwhile, efficiencies might be achieved in terms of employments, since the providers would not need any intermediary or dedicated employee for such operations, hence the cost to employ can be lower than a traditional employment arrangement.

Second, the important role of logistics plays in supporting supply chain strategies requires the need of having the highest standards. For instance, through warehouse, suppliers can afford to locate inventory closer to their customers, permitting more frequent and/or faster deliveries to be provided. Third, sharing could help the industry achieve better emission rates by facilitating improved capacity utilization and fill rates. Furthermore, sharing results in using assets more effectively and preventing empty miles.

Logistics providers have an essential role in facilitating the growth of the Sharing Economy by using their complex know-how to optimize the delivery time, lower transportation costs and thereby grow the overall demand. The capabilities such as shared warehouse and shared transport are expected to increase asset utilization in the near future. [15] Crowd-shipping is a major opportunity – and threat to the traditional trucking industry, which is capable of better matching demand with supply for both road freight operators and even individuals by leveraging the smartphone app technologies. The WEF believes that traditional trucking companies could lose US \$ 310 billions of profits to companies using crowd-sourced platforms.

3.3 Disintermediation and the End of Middlemen

Efficiency, standardisation and low cost were the key success factors of logistics providers until the rise of digitalization. Since decades, freight forwarders have organized transportation on behalf of shippers, and established contacts with carriers to move goods at stable prices. Additionally, they provided consolidated invoicing because shippers do

not need to interact with all the carriers, or all other third parties such as ground handling agents, customs agents, etc. involved. They have too many roles from supply chain, warehousing, packaging to documentation experts without the need of physical assets. As a consequence, freight forwarding industry is vulnerable to such disintermediation model of digital platforms, due to its high potential that would reduce the need for them.

Digital platforms aim to position themselves to provide better customer experience with almost no physical assets and purely relied on IT solutions, taking over the role of traditional intermediaries. This results in status quo challenge with the increased competitiveness in the industry, threatening the traditional business model.

First of all, established incumbents are not capable of integrating new technologies while cash/capex requirements do not allow them for making heavy investments to recover IT enhancements. According to the SAP Digital Transformation Executive Study[16] 21% of the SMEs confirmed the lack of financial resources as the principal obstacle to transform into fully digital, followed by lack of time (15%) and the sophistication of such technology. Moreover, they typically do not have organizational culture to adopt innovation process and new business models. On the other hand, the report states large corporations consider lack of knowledge and experience of company personnel are one of biggest issue (25%).

3.4 Cloud-Based Technology

The introduction of cloud services initiated the new subscription-based business models that are causing big challenges to traditional service providers. Because they will have to migrate current systems to the cloud which will entail a massive overhaul of the applications at a large expense, thus maintaining established customer care contacts. On the other hand, customers are also looking for more flexible, lower-cost alternatives and moving away from expensive licensing and support agreements.

Many organizations are implementing various low-cost applications from external cloud vendors, since they are unable to wait until the internal IT function is ready to service their requests. Considering the fact that critical data of client and operations may end up on many mobile devices operating as outsider, this option includes possible security and

data management challenges. Therefore, established LSPs with substantial investments in ERP and other internal server-based applications, need to consider how sensitive operational data can be migrated to cloud computing platforms. Instead, smaller LSPs and new market entrants can adopt operations almost immediately, selecting from a variety of applications as requirements demand.

Cloud computing gives rise to new ‘logistics-as-a-service’ (LaaS)-based business models which is ideal for complex and dynamic environment like logistics industry. Modular cloud logistics platforms provide open access to plenty of configurable on-demand logistics-related IT services that can be easily integrated into critical supply chain processes such as orders, billing, and track & trace services. Meanwhile, pay-per-use models permits small and medium-sized logistics providers as well as larger companies to react more flexibly to market volatility, paying only for the services they use, instead of investing in a fixed-capacity IT infrastructure. Companies using cloud-based solutions can budget for them as operating expenditure.

This is a strategical decision which consists of realignment the expense of emerging new technology services, moving from in-house capital spending to a more agile, subscription based operating model. It allows small logistic service providers to exploit a considerable cost advantage by utilizing new platforms and provide solutions to customers very quickly, without having to make the massive investments that incumbent players have made.

There are many technical solutions that serve communication and have been facilitating cooperation in supply chains for years. Platforms and collaborative networks are at the heart of the new digital economy, with 60–70% of new value created in the next ten years expected to be based many other data-driven digitally enabled networks and platforms.

Cloud technology is the best way to integrate the supply chain. This is not only about the communication itself, but also about sharing data, integration of various devices that generate these data, as well as creating a single channel for data retrieval.

All this takes place without significant expenditure, considering that services in the cloud can be purchased in the form of access to external infrastructure. There is no need to build

own infrastructure. Different devices can simultaneously use the cloud both in the process of data capture (upload) and data retrieval (download).

This means the integration of various hardware platforms, different operating systems and a variety of user applications, including ERP systems is available. The cloud contributes significantly to the creation of a unified ICT platform for the supply chain – a platform that enables real-time supply chain management (with on-line visibility), contributes to the creation of cyber- physical systems, and allows real and active inclusion of field service processes in the supply chain as well as the final customer. Cloud technologies have also contributed significantly to the popularity of mobile devices that can be directly used in supply chain management.

Moreover, a cloud-based SaaS marketplace is a type of marketplace where users can search, find and purchase. The platform offers functionalities such as listing, comparing other products and refer a vendor to complete online purchases which improve customer experience. Customers are able to store and analyse their own data via the application without having need to invest time in installing, managing or upgrading the software, since these activities are provider's responsibilities.

4 DIGITAL FREIGHT MARKETPLACES

The success of Uber and similar on-demand capacity sharing platforms has fostered the creation of technology-enabled freight marketplaces that match companies looking to ship the goods using one or multiple modes of transport (road, air, ocean, and/or rail) with suppliers or brokers of logistics capacity.

These platforms provide visibility on the information, rates, and additional services from different providers in order to enable solutions that better meet the needs of each stakeholder.

4.1 Categorization of Digital Freight Marketplaces

In spot market, the shippers post requests for quotation (RFQ) including their urgent requirements, on the freight marketplace with reverse auction capabilities, and carriers view and respond by competitively bidding to the load tenders. Thus, the direct interaction without the need of a middleman between two parties starts. At the end, the shippers' book like an Expedia for their freight selecting the carrier who best fit their criteria among all offers and make the payment online. The participation of large and especially middle size shippers is increasing rapidly in consequence of the easy access to spot rates via such centralized marketplaces. Instead, in long term contracting the shippers participate in long-term contracts with the logistics providers over the period of the contract for receiving required services along the contracted lanes at a given price, only if the carrier has the capacity to provide such service.

The loads can be submitted in public or private marketplaces. A public marketplace is a platform where all approved carriers can participate in exchange, while only contracted or in-house ones can participate in the private marketplaces. Since the reliability is the most important indicator in online platforms, some public marketplaces confirm only certified carriers based on several requirements related to their service records and credentials.

The marketplaces can also be categorized depending on the responsibility that they take over in the overall logistical processes. A neutral marketplace, called also as digital freight brokerage platform, offers capabilities for the shippers and carriers to match their demands, and is not involved in the actual execution of the agreements. Both specific modal and inter-modal services can be found on the marketplaces. They can also be differentiated by the geographical scope of their operations.

4.2 LOAD BOARDS

Today, almost all of the 1 billion tonnes of spot freight in the US (representing 15 – 20% of total road freight) is managed through load boards. US load boards have evolved over the last 2-3 decades, initially enabling only discovery.

Load board is an online platform that helps both shippers and traditional freight brokers connect with the registered carriers, however, does not take responsibility for the successful execution of the transaction, e.g. DAT, Truckstop.com, 123Loadboard. These types of platforms are usually used by truckers and shippers to create network and match loads by themselves, while freight brokers might also use these load boards to connect shippers and carriers to reduce search costs.

This way shippers or freight brokers insert load details to a web-based platform and reaches a wide base of available truckers. Truckers searching for loads can log in to the board, post empty space details and search listed postings to find one that matches their requirements. The carrier usually pays a low subscription fee to access available. Rates are negotiated between the shipper and carrier as in a traditional brokerage model and the transaction is subsequently completed offline.

To date, load boards have added valuable features such as load tracking, price benchmarking and access to carrier ratings for shippers. Nowadays many of them also help truckers plan routes and provide access to maintenance services. However, the platform does not provide the management of contacts, paperwork, billing and other processes involved with load transportation.

The biggest concern of load board users is the reliability, because of the fact that both parties involve unknown logistics partners to their processes. Moreover, even though these platforms improve common logistics issues such as transparency, pricing options, and carrier reach to a certain level, available value-added services on the platform are quite limited.

4.2.1 CASE STUDY: DAT

DAT (Dial-a-Truck) is the oldest and largest load board in North America, along with Truckstop.com, accounts for nearly 85% of the load board market. It also provides a broker transport management system solution as well as trucking trends-based analysis of over 260 million loads posted annually on its platform. The company claims its truckload rates are based on \$57 billion in actual freight payments on its platform. The company provides real-time manual freight matching service (web-based load board with mobile app) where brokers and shippers can post loads with also enterprise solution offerings. Since it is founded in 1978, there is a strong network of integration partners such as Getloaded and Link Logistics (Canada). Its estimated revenue in 2018 was \$710 million only from load board solution.

The pricing model is based on monthly subscription within differentiated package options; for carriers \$149 per month for basic DAT Power Select package, and DAT Power Office for \$249/month DAT with better monitoring and matching analysis option while for brokers the membership price is \$190 per month. The shippers benefit more customized pricing options under the subscription of premium packages. As a service to the industry, DAT provides data on trends, including a monthly spot market freight index and weekly trend line update. The target customers are owner operators and small medium size carriers such as Heitz Trucking Inc., TMC Logistics as well as brokers and private fleets. On the platform, extensive value-added service offerings such as TMS logistics software, fleet management services, cargo insurance, financing and carrier payment are available for carriers. Instead, the customized solutions that verified vehicle and cargo insurance and safety ratings on a daily basis to check for any changes with carriers are offered to the shipper members.

4.3 DIGITAL FREIGHT BROKERAGE

Digital freight brokerage platforms that are reinventing the road freight industry and improving enormous inefficiencies of unused truck capacity. These digital freight brokerage platforms enable real-time data flow and communication between shippers and carriers, and thus provide optimum matching of loads with available capacity.

The business model of such marketplaces is typically a commission-based platform which takes a certain percentage of each transaction, either from the carrier, shipper or even both, in return of providing the market access and handling of transactions.

On the other hand, automated on-demand freight brokerage solutions deliver greater efficiency and ease in the freight brokerage process for shippers. As an end-to-end technology, these solutions also help carriers with document automation, fleet management systems, and guaranteed payments within 24 to 72 hours.

Apart from apps, product/service providers are also offering digital freight aggregation services that leverage telematics and Big Data. Potential savings of digital freight brokerage solutions that enable greater load efficiency and lower empty miles includes lower fuel costs and lesser greenhouse gas emissions.

The benefits of the model include real-time communication, shipment tracking via mobile GPS, secure payment, and critical document capture, all conveniently conducted within a mobile app. In addition, sharing economy model permits a real-time shipment transparency while effectively share excess capacity in all transport modes with a greater audience of shippers.

4.3.1 CASE STUDY: TRANSFIX

Tranfix is founded in 2013 in New York. It is among few functionally automated on-demand brokerages solution, albeit for contracted shippers alone, which competes with radiational brokerage companies/brokers with superior technology. The company provides automated load matching service that serves in 48 states primarily focus on the

FTL market for commercialized freight; connects shippers for carriers seamlessly through its platform. Its unique value proposition is the instant load booking through portal/app and carriers guaranteed payment with 48 hrs of upload of proof-of-delivery. The company had received \$78.5 million over various rounds; the latest was \$42 million in Series C financing round in 2017, led by New Enterprise Associate (NEA).

Transfix built a strong foundation by first understanding the fundamentals of the trucking industry; more specifically FTL and long-haul, before developing a real-time on demand platform for shippers and carriers. It is one of the members of BiTA (Blockchain).

The revenue model of the platform is based on commission which is from 5% to 10% on the load price within a shipper contract. Shippers are allowed to post loads, rates and receive bids from carriers. End-to-end transaction can be completed on the platform. The platform is free for carriers who can browse available loads on portal, view detailed information about particular load and book if they find the rate agreeable. The option to bid higher through the portal/app or over the phone is possible through Transfix's booking team.

4.3.2 CASE STUDY: CARGOBASE

Cargobase provides an online marketplace for the quotation and booking of freight, with features for reporting, tracking and payments. The platform supports spot market bookings for air, sea road and parcel shipments, which allows users to compare offerings across different modes of transport. In 2016, the company added features to support pre-negotiated forwarding contracts within its platform, allowing users to choose between spot market options and existing contracted providers, depending on the situation. Cargobase runs a cloud-based SaaS platform, which supports a spot market exchange for cargo. The platform is connected to over 300 logistics service providers, such as Kuehne+Nagel, Expeditors, DSV, FedEx and DHL. In addition, data from 350 commercial airlines is also fed onto the platform. The platform initially focused on air freight (aircraft charters, on-board couriers, next-flight-out, regular air freight) and road freight. Ocean freight was added in 2016, with parcels added in 2017. Cargobase launched a mobile app, 'On the Go', in 2017. The mobile application allows users to book, approve and track shipments, as well as interact with logistics service providers. The company has received US \$1.3m in funding.

4.4 CASE STUDY: UBER FREIGHT

Uber Freight is a business of Uber Technologies Inc. which the company has stated is potentially one of its largest revenue generators. It is announced that Uber Freight has achieved a monthly revenue run rate of \$ 40 million in 2018 and it intends to double investment in the business, although it has publicly informed abandonment of plans for autonomous trucks. The platform is based on Uber's solution to automate freight brokerage much like its ride-hailing business. Fleet mode allows fleet managers of small fleets to not only book loads, but also assign them to various drivers within the fleet. With its Powerloop product, the company targets owner-operators/small-medium fleets to trailer-pool programs. Powerloop rents trailers to small-medium carriers (up to 10 trucks) for \$25/day and helps connect shipper pre-loaded trailers. Uber Freight has been looking to attract carriers with its Uber Freight Plus, a program that offers savings on fuel, parts, and even new and used truck purchases to carriers actively using the app.

The business model is based on up-front pricing by platform using its marketplace dynamics team, which calibrates prices based on driver performance, live location, load type, and weight. Uber Freight Plus discounts for carriers are available for carriers hauling at least one load per month through Uber Freight.

4.5 FREIGHT EXCHANGES

Freight Exchanges are pure SaaS companies that are offering price comparisons and route optimisation for international and trans-modal logistics services, as well as providing additional services like freight rate and contract management. Pricing model may include a mix of subscription and referral revenues for the provided services. Basically, these platforms are designed to connect shippers and carriers more quickly and efficiently, improving customer experience and operational inefficiencies while helping carriers maximize their productivity and asset utilization which result in lower costs for shippers.

The beneficial key functions of such platforms are discussed below, highlighting the main differences between traditional methods.

- 1) **Instant price quotation:** Digital processes enable better experiences to customers through available functions on platforms such as instant quotes with the opportunity to compare rates. For instance, Freightos platform provides an instant freight quote engine which makes possible pricing within seconds. According to Freightos report, only 25% of the world's top twenty freight forwarder are capable of providing LCL online quotes. On average, it would take them 57 hours to receive a price quote, and get offers with a large spread of 58%, highlighting the lack of transparency of the method. Meanwhile, Freightos guarantees 100% transparency and lets their customers now instantly book a shipment on their website which is similar to booking a hotel or a flight.

- 2) **Automated documentation:** Instead of producing traditional way of time-consuming paperwork, these platforms offer to collect all documents within their secure cloud, which allows customers to share documents like the bill of lading, invoices or a packing list with their collaborators. Twill, another digital freight forwarder platform owning by Maersk's freight forwarder unit Damco, handles all the documents digitally and collects them in a secure place, instead of attaching to emails.

Shippers and forwarders can achieve significant cost savings through automating invoicing and payments with integrated financial system. They could save between \$15 and \$50 per invoice and with less of probability of incorrect information, considering 20% of the invoices in freight and logistics are incorrect

- 3) **Asset tracking and customer services:** Online platforms enable automated tracking of the shipments through notification system. Therefore, customers know where their cargo and who to communicate with. Additionally, digital platforms include chatbots which improve the communication flow and to answer in a shorter time.

- 4) **Enhanced forecasting through big data and analytics:** Forecasting and analytics features allow customers know about the price changes in the market and predict whether it is the most convenient time to ship. Freightos, for example, developed its Baltic index to forecast the rates.

That's how digital freight forwarders plan to increase their market share with higher customer satisfaction, lower unit costs and greater profitability through their platforms. In other words, digital freight forwarders are mainly leaning on technology to be more efficient and to offer a better customer experience, which is giving them a lot of profit.

In certain ways, the freight marketplaces represent a mixture between the traditional freight brokerage model and the modern e-commerce model. These platforms enable real-time quotes and flexible sourcing without heavy dependencies on long-term partnerships, through an easy access to a wider range of deals. However, due to the required intermediary functions in transportation industry, it is anticipated that freight forwarding will still persist despite rapid diffusion of digital solutions.

4.5.1 CASE STUDY: FLEXPOR

Flexport is a digital freight forwarder powered by unified, structured data, interfacing with clients through APIs. It does not offer customers instant quotation or pricing transparency but does provide end-to-end forwarding services including customs clearance. The company is primarily focused on the Eastbound Trans-Pacific trade lane, from Asia to the US west Coast, but also has operations in the Netherlands.

Flexport's software can provide pallet-level visibility over shipments, which it is building into its customer API. The company also runs software for compliance, a platform for asst-owners (principally road freight companies) and can facilitate the integration of shippers and carriers through its purchase order management software. While other companies can offer these services, they are often based on older technologies and come at a greater cost. It offers services in air freight, ocean freight, trucking, warehouse & fulfillment, customs brokerage, and cargo insurance.

The startup is looking for reliable freight forwarding partners, specifically looking for ocean FCL/LCL, air freight, trucking and fulfillment. It is not using software to automate the entirety of the supply chain, but it is a fully licensed freight forwarder where people manage clients' freight movements with dedicated teams that take end-to-end responsibility for the success of every client, including a licensed customs broker, logistics manager, and operations coordinators.

Flexport has built all of its applications from the ground up as part of a unified software platform, which avoids the integration issues larger forwarders experience as a result of siloed business units or M&A. This backend allows for far easier interfaces for shippers and carriers, and the company's self-service web interface is a big draw for SME customers, which represent a large portion of Flexport's customer base which are three types: small companies selling on Amazon; large, traditional businesses interested in both air and sea freight (including Bridgestone Tyres); and fast-growing e-commerce companies that have not had time to develop their logistics capabilities

The revenue model is based on commissions and fee for services. Percentage of the cost of the services is charged by Flexport and for the additional services such as operation management solution, analytics-based optimization there are extra fees.

4.6 The Threats for Industry Incumbents

Smart strategies within the digital transformation are much required in order to stay in the game and achieve competitiveness. There are several options once the incumbents decide to take a step further to embrace the new paradigm.

First of all, they can simply collaborate with new tech-led entrants to build on their existing capabilities, benefiting from expanded own/joint value chain. Acquisition or investing in such start-ups might be another way ahead to internalize all the operations. The third option is creating own in-house bottom up innovation process of IT solutions.

Looking at these results, some users may feel that the quotation and booking platforms presently on offer do not offer value for money. Nevertheless, many others are clearly willing to embrace the potential of these systems, even if this may only apply to certain shipments on certain routes. As time goes by, these systems will inevitably become more comprehensive and robust.

Within the freight forwarding ecosystem, players from all market categories have already exploited the industry's digital potential. Of these, the digital leaders among the shippers (or customers of freight forwarders) are keenly aware of the digitalization potential and have already started to integrate backwards.

To better analyze the current situation of the industry, five types of new company attempts that threaten incumbents are listed below.

- 1) **Competitors incubating:** Traditional forwarders like Agility's Shipa Freight, Kuehne + Nagel and Damco's Twill Logistics are already digitizing their approach, incubating new business models to provide better experience to their clients while enhancing the offered benefits within additional services.
- 2) **Suppliers digitizing:** The leader carriers, such as Maersk and Hapag-Lloyd, also initiated digital transformation on their system to keep up with the market's requirements. They are able to offer instant quotes directly to shippers and leaving the freight forwarders aside to reduce the time spent on searching and booking a freight.
- 3) **Startups emerging:** Startups offer better customer experience with solutions adapted to the client's needs with more visibility along with the supply chain by developing digital business models. As mentioned previously, they are simply matchmakers and derive their profit from transactions for platform usage while not having any transport liability, e.g. Freightos, uShip or Uber Freight. Other startups leverage their IT capabilities in related fields such as virtual supply chain management, real-time pricing or volume forecasting.

- 4) **Customers becoming competitors:** Some of the freight forwarders' bigger clients with strong technological capacities are working to improving online customer experience which gives them greater control like Amazon.
- 5) **Integrators entering the logistics industry:** Meanwhile, big three integrators UPS, FedEx and DHL are in constant expansion of their activities in logistics, which are already advantaged of their end-to-end IT systems. Due to their direct control over assets, they are more likely to provide much better tracking and visibility capabilities which are the biggest advantages of express integrators.

As a conclusion, it would be perfect to annex the statement of Ryan Peterson, CEO Flexport, about the main threats to established players in the industry:

“There are two ways logistic companies can attain scale: Through acquisitions or with technology. Technology might limit how quickly you can grow because you can't acquire your way to scale. On the other hand, scale eventually becomes a hindrance to the acquirer as it struggles to tie together legacy platforms. (Peterson,2018)”

These digitalization initiatives clearly demonstrate the competition among all the stakeholders from forwarding incumbents, startups, carriers, and to shippers. However, there is still no Airbnb platform of freight forwarding. Despite the numerous attempts of many players digitalization has failed to exert its disrupting potential, meanwhile big players such as Kuehne + Nagel, DHL, and Panalpina still earn billions with their traditional business model. Forwarding market remains a highly fragmented with hundreds of thousands of players operating in this market where even market leaders have low market shares, low bargaining power, and are far from generating high margins.

4.6.1 CASE STUDY: CH ROBINSON'S FREIGHTQUOTE

CH Robinson is a non-asset based giant 3PL that views itself primarily as a service company. It acquired digital brokerage solution company Freightquote in 2015. CH Robinsons' Navisphere technology platform provides customers with a flexible integrated technology solution that provides visibility to all transportation activities. CH

Robinson offers a proprietary TMS solution named TMC and brings all aspects of the supply chain together.

The revenue model consists of pre-fixed per mile based on shipping location for carriers and negotiated contract or commission per booking for shipper. The platform offers competitive rates to transport freight through any mode. Customized transportation solution catered to the needs of the shipper at any point of the supply chain. Its target is FTL and LTL with small carriers (less than 100 trucks) and from Fortune 100 to small family businesses as shippers.

4.6.2 CASE STUDY: UPS's COYOTE

UPS did not used to have an asset-heavy road freight business comparable to UPS Freight in North America throughout Europe region. When the company has scaled up significantly its European express operations and became also well-known in the continent for its contract logistics activities, it acquired Coyote logistics in 2015 for \$ 2 billion.

Coyote, founded in 2006, is one of a previous generation of digital brokerage firms in the road freight sector and has evolved gradually over time by merging conventional brokerage with innovative web-based tools to better match freight with available capacity. Even though the digital technologies are used, it operates similar to traditional broker employing a team of customer representatives to improve brokerage speed. By 2015, the company was growing rapidly, and UPS acquired it following three years in which they have collaborated for extra capacity during demand peaks.

Following Coyote's fast success in the UPS Supply Chin and Freight business, the organization agreed to duplicate the pattern in Europe by purchasing a similar company, FreightEx, and developing transparent infrastructure and integration activities. The takeover of FreightEx allows UPS to expand into the European road freight market without committing to the development of an expensive, asset-based network of operations.

The pricing for both carriers and shippers is commission based per transaction. Commissions range from 7% to 30% depending on nature of load, urgency of shipment, costs involved and other related factors. Real price bidding with market rates are available for carriers and the platform identifies best carriers for a load based on multiple factors including net economic benefit.

4.7 Key Challenges in the Current Marketplaces Models

While marketplaces have clear advantages over the traditional brokerage and load board models, as far as customers are concerned, they also have a few shortcomings.

- *Service quality.* The matching shippers with carriers' process may be transparent, however there is no guarantee about the service quality of the selected carriers. As a result, the digital logistics marketplaces may compound the problem further instead of resolving the existing trust issues in the industry.
- *Lack of customer-centric experiences in the marketplaces.* Spot quotes offered on these marketplaces to both the shippers and carriers are usually standardized. However, the parties concerned might need customized rates on the basis of their current demand and supply status. More customized services have become the strategy path for almost all most industries just like in the logistics industry as well. The lack of customer-centric experiences in digital freight marketplaces may prove to be a roadblock on this path.
- *Unavailability of value-added services.* Value-added services are rarely found and offered on marketplaces. Even though the basic requirements of the concerned parties are met, the unavailability of value-added services may turn them away from these marketplaces.
- *Misleading reviews and trust issue.* Shippers are reliant on the marketplace's reviews of the carriers listed on the platform. These reviews are not verifiable, and shippers are forced to do a bit of research on their own to verify the reviews.

- *Inaccurate quotes and manual processes.* Many marketplaces still rely on quotes from freight forwarders who still compile the quote requests through manual processes. The timeliness and accuracy of such a method are questionable. Some users report that the communication often ends abruptly with the quote, which means that they have to contact the carrier through phone or email; resulting in a needless waste of time.

5 DISRUPTIVE TECHNOLOGIES

The challenges faced by the current freight marketplaces can be overcome, if various high technologies are leveraged. It is essential for an innovator to tackle an industry problem that, if fixed, will release value fully or partly to the innovator.

First of all, as mentioned previously, trust issue is the main concern for all types of digital marketplaces where a variety of stakeholders, who might be unfamiliar with each other, are brought together. The features of blockchain would become key differentiators due to its capability of ensuring trust and assurance in each transaction. Furthermore, a blockchain decentralized marketplace platform is developed to serve end-to-end integrity across entire functions such as track and trace, ratings and feedbacks, and even invoice audits.

Recently, freight exchanges are implementing intelligent algorithms based on probabilistic capabilities and data analytics in order to offer customized, dynamic spot rates for shippers while achieving great competitive advantage through other types of digital platforms. Furthermore, telematics technology provides up-to-date information when carriers broadcast their current locations. This would help the number of carriers increase which is the most critical factor that is defining the strength of the digital freight marketplaces.

5.1 Internet of Things and Low-Cost Sensor Technology

The Internet of Things (IoT) has the potential to connect virtually anything to the Internet and accelerate data-driven logistics that enables tracking capabilities. Tracking technology provides continuous, real-time information regarding the position and load status of each trailer and container, often using solar and cellular power. [18]

It is estimated that by the end of 2020, more than 50 billion objects will be connected to the Internet, presenting an immense \$1.9 trillion opportunity in logistics. The increasing level of sensor usage and vehicle telematics allow logistics managers to obtain data daily on mechanical performance of vehicles and behavioural patterns of drivers, such as vehicle speed, direction, braking, performance of engine and mechanical components.

These capabilities can lead to improve driver behaviour while reducing fuel consumption and CO2 emissions as well. This results in the improved maintenance of vehicles, less downtime and fewer breakdowns.

Today's increasing application of low-cost sensors found in almost every consumer electronics (accelerometers, gyroscopes, temperature, humidity, etc.) will expand significantly in the future. Using smartphones and tablets for logistics processes is already a current industry trend. The first applications (e.g., barcode scanning, image documentation of freight, and signature capturing on delivery) exploit the different technical capabilities of mobile devices and utilize cloud-based software-as-a-service models. New logistics use cases will be born with the spread of NFC-compatible smartphones such as identifying items wirelessly with RFID transponders and scanning electronically with a smartphone camera which could eliminate costly conventional scanner systems.

Connected warehouses will increase the transparency and localization of all assets by tagging of individual items, pallets, and operational hardware. Intelligent transportation solutions through innovative smart truck concepts aim at improving transparency in supply chain as well. Truck telematics devices have been gaining steady penetration, resulting in digitalization opportunities. For instance, in-vehicle telematics collect data on movements and unproductive time to optimize fleet and asset utilization. IoT might also be used to reduce vehicle downtime by predicting the asset failure and scheduling automated maintenance.

Other benefits of IoT include:

- real-time monitoring the status of assets, parcels and people;
- measuring how assets are performing and forecasting what they will do next;
- reducing fuel costs by optimization of fleet routes;
- automating the processes to prevent manual interventions;
- optimizing the coordination of interactive work of people, systems and assets together;
- applying analytics to achieve further improvement opportunities;
- real-time monitoring inventory to reduce waste.

5.2 Big Data and Artificial Intelligence

The global increase in use of low-cost sensors had led to the rise of Big Data. Logistics is being transformed through data-driven capabilities. Thanks to the rapid diffusion of digitalization, extraordinary amounts of data can be captured from various sources along the supply chain that are used to optimize capacity utilization, reduce risk, improve customer experience and create new business models in logistics.

Big data has already started to create a revolution in the logistics industry by transforming massive data quantities into strategic tools to boost efficiency and productivity in areas such as capacity planning and vehicle route optimization. In addition, the advancement of analytics technologies will open new ways to monetize data-driven operating and business models.

First of all, operational efficiency will be improved by using big data to maximize resource utilization and optimize process quality and performance, increasing speed and transparency in decision making procedures. For instance, the intelligent correlation of data streams such as shipment information, weather, traffic, etc. enable real-time scheduling of assignments, optimization of load sequences, and ‘down-to-the-minute’ prediction of the estimated time of arrival (ETA). All customer interactions and operational performance indicators are also integrated to the systems which leads companies to provide customer experience.

Big data can be used to mitigate risk by detecting, evaluating, and alerting all potential disruptions thanks to end-to-end supply chain risk management based on predictive analytics. New business models are evolving for logistics companies to broaden income opportunities and deliver new data-based products.

Despite of all the benefits and opportunities of this technology, privacy concerns regarding data collection and protection still persist. There is the need for appropriate data science skills in industry to achieve better data quality and data access.

6 BLOCKCHAIN

The blockchain phenomenon is discussed in this chapter, outlining the most prominent use cases in the areas of global trade logistics, supply chain transparency and traceability in order to better demonstrate its promising solutions to current problems in the industry and inevitable advantages to the companies who manage to implement it. The key challenges for adoption of the technology is also mentioned objectively. In the final part, several real-time start-ups that are integrating blockchain technology into their digital platforms are explored to highlight how these new entrants are using disruptive business model opportunities by exploiting the capabilities of this technology.

6.1 Blockchain Technology

Blockchain is a transactional database, which is distributed among nodes linked in a peer-to-peer (P2P) communication network. It is a shared digital ledger encompassing a list of connected blocks stored on a decentralized distributed network that is secured through cryptography. The access to the network is based on a permission mechanism, which enables the nodes to perform transactions that hold validity based on a consensus mechanism. Each *node* is connected to the blockchain network and gets a copy of the chain of connected reconciled records (the blockchain). The *blocks* (information), in a blockchain exists as shared and continuously updated database and is secured by design.

Blockchain technology has created a new form of internet that can be suitable for the recording of events, medical history, trading, shipping, supply chain and many others. In logistics, blockchain is expected to boost the physical and digital connectivity and also to provide end to end visibility to all stake holders. [19]

The traditional way of exchange a document in a network is by forwarding the document to other recipient for updating and modification, in which the sender has to wait to receive the modified copy to check or make further changes to it. In the blockchain technology the document is not exchanged physically or digitally instead, the relevant data is shared and distributed along the network. Hence, both parties have access to the same version of the document at the same time. On the other hand, online transactions are subject to security measures like identity verification using encryption technology by means of the public and private “keys”.

6.2 Main Characteristics

The revolutionary power of blockchain comes from a unique combination of its differentiating features and characteristics. A summary of the four key features is listed below– these are data transparency, security, asset management and smart contracts. [22]

1. *Data transparency.* Blockchain technology involves mechanisms to provide accurate, tamper-evident, stored records from a verifiable source. Thus, instead of multiple parties maintaining and modifying copies of their own dataset, every stakeholder receives controlled access to a public dataset that provides a common source of truth. This brings confidence to those operating on this data that they have the most up-to-date, precise and secure dataset.
2. *Security.* Traditional ledgers usually have a security layer, if compromised, allows access to all written data. In a blockchain-based system, the security mechanisms make sure that individual transactions and messages are cryptographically signed. This ensures essential security and effective risk management to tackle today's high risks of hacking, data manipulation, and data compromise.
3. *Asset management.* Blockchain technology can be used to manage the ownership of digital assets and facilitate asset transfers. For example, it can be used to track the ownership of titles (e.g., land titles and diamond certificates) and rights (e.g., copyright and mineral rights). It can also be used to manage the digital twin of a physical object in the real world.
4. *Smart contracts.* A smart contract is a component of a blockchain-based system that can automatically enforce stakeholder-agreed rules and process steps. Once launched, smart contracts are fully autonomous; when contract conditions are met, pre-specified and agreed actions occur automatically. Considering many of the issues set out earlier such as trust, complexity, time and paper-based inefficiencies, the benefits that smart contracts can deliver to logistics sector are substantial.

Such capabilities are implemented through two forms of blockchain-based systems: public decentralized blockchain where anybody may join (i.e. bitcoin network) and private permissioned blockchains where participants must be safe listed. Since public blockchains can be used by many parties, they are more likely to foster innovation.

However today, companies prefer to adopt private permissioned blockchains because of privacy concerns. Therefore, the choice between using public versus private blockchains should be determined by the individual needs of each blockchain implementation.

6.3 The promise of Blockchain in Logistics

Blockchain would be one of the most promising technologies in logistics since it proposes solutions to the most common problems of the industry. Today, there is still a considerable amount of lost value in logistics, mainly stemming from its highly fragmented and competitive nature.

Drive efficiency in global trade

The logistics behind global trade is highly complex as it involves many stakeholders often with conflicting interests and priorities as well as the use of different systems to track shipments. Therefore, achieving efficiencies in trade logistics would bring a significant impact on the global economy. According to one estimate from the World Economic Forum, reducing supply chain barriers to trade could increase global gross domestic product (GDP) by nearly 5% and global trade by 15%.

First of all, current trading and shipping practices rely heavily on paper-based documents. One example that highlights the inefficiencies behind ocean freight today is the estimate that a simple shipment of refrigerated goods from East Africa to Europe can go through nearly 30 people and organizations, with more than 200 different interactions and communications among these parties. This heavy approach increases the dwell time and becomes considerable costly while limiting the accuracy of data, as a result. Current industry estimates indicate that 10% of all freight invoices contain inaccurate data which leads to disputes as well as many other process inefficiencies in the logistics industry.

Blockchain technology has huge potential to optimize the cost as well as time associated with trade documentation and administrative processing for ocean freight shipments.

Developing trust

Existing trust models in the industry are almost always constructed around a third party acting as the reference point. For example, a bank guaranteeing the transfer of funds

between parties or foreign exchange markets using brokers to manage the transaction flows between buyer and seller while the third party is required to validate and confirm the transactions. This system often involves drawbacks in terms of efficiencies and sometimes cost.

Blockchain protocols remove the requirement for a mediator third party between all of the participants in a transaction chain. Therefore, blockchain can provide a trust mechanism in a commercial environment where there are numerous participants who need to establish relationships and transfer funds, often for the first time in a very compressed time frame thanks to its consensus model that distributes trust across a network by using cryptography. This way, it enforces the trusted environment guaranteed by the consensus of all of the participation effect that leads to replace the single intermediary who usually validates any transactions with a series of consensus rules. One of the other factors of this model is that the identity of the party contributing data and information onto the blockchain is recorded.

The blockchain trust model is the biggest innovation with this technology, as it is redefining what trust means and how it can work at scale across digital services. According to IBM, the absence of a single controlling organization will encourage more participation and disputes will be minimized as the truth is distributed across the network.

Blockchain technology transforms the way that shipping and international trade works by ensuring that stored data records are tamper-free and from a verifiable source, allowing all participants to feel trust and confidence in a single source of truth. These same qualities mean the technology removes the need to have a trusted central counterparty or for any particular stakeholder to own the blockchain platform.

USECASE: IBM AND MAERSK

In order to improve efficiency in ocean freight, Maersk and IBM have started a venture in 2018, to establish a global blockchain-based system for digitizing trade workflows and end-to-end shipment tracking. The system permits each stakeholder in the supply chain to monitor the progress of goods through the supply chain, understanding where a container is in transit. Stakeholders can also see the status of customs documents and can

view bills of lading and other data. Blockchain technology ensures secure data exchange and a tamper-proof repository for this documentation.

More than \$ 4 trillion goods are shipped each year and 80% of them are carried by the ocean shipping industry. By reducing barriers within the international supply chain, global trade could increase by nearly 15%, boosting economies and creating more jobs. The cost of the required trade documentations is estimated to reach one-fifth of the actual physical transportation costs in maritime industry. Therefore, the goals of this platform is reducing global trade barriers and increasing efficiency across international supply chains, and bringing to market a trade platform for connecting the entire supply chain ecosystem.

The two main superior capabilities at launch will address; providing end-to-end supply chain visibility that enables all stakeholders involved in a global shipping transaction in real time more securely and digitizing paperwork filings for the import and export of goods by enabling end users to submit, stamp and approve documents.

The platform has been tested by few selected partners who all have interest in developing smarter processes for trade. The two companies expect this solution to track tens of millions of shipping containers annually. The new venture platform has the potential to significantly reduce delays and fraud, which could lead to billions of dollars in savings in the logistics industry.

Improving Transparency and Traceability in Supply Chains

Moving forward, a key requirement for track-and-trace applications will be to adopt more secure and intelligent forms of digital identity for each physical product – moving from the provision of a passive barcode or serial number to, for example, enabling interactivity with the use of Internet of Things (IoT) sensors. Smart devices can be securely tied to or embedded in the physical product to autonomously record and transmit data about item condition including temperature variation, to ensure product integrity, as well as any evidence of product tampering.

Organizations have been using GPS technology in order to track freight-hauling assets since years. Location updates were provided by check calls and the use of fax machines

back in the history. Later, they were replaced with automated digital systems such as EDIs and APIs. Since the industry faces increasing customer expectations and retailers try to satisfy them by promising delivery services in shortest time possible, traditional methods will never scale.

In short, adopting blockchain technology will enable all supply chain stakeholders in the network to securely share the relevant information on a real time basis. The documents are no longer exchanged physically or digitally instead, the relevant data is shared and distributed using blockchain technology. This technology can also enable data transparency and access among relevant supply chain stakeholders, creating a single source of truth. In addition, the trust that is required between stakeholders to share information is enhanced by the intrinsic security mechanisms of blockchain technology.

Furthermore, blockchain can achieve cost savings by powering leaner, more automated, and error-free processes. As well as adding visibility and predictability to logistics operations, it can accelerate the physical flow of goods. Provenance tracking of goods can enable responsible and sustainable supply chains at scale and help to tackle product counterfeiting. Additionally, blockchain-based solutions offer potential for new logistics services and more innovative business models.

Blockchain's potential to transform the shipping industry springs from its ability to provide a more secure and transparent way to handle exchanges of information between parties.

This technology is said to cut transport costs by speeding up the entire flow of transport documents. It also said to reduce the requirement for data entry by up to 80%, simplify data amendments across the shipping process, streamline the checks required for cargo and reduce the burden and risk of penalties for customs compliance levied on customers. The data will be safer with stronger security through public-key cryptography.

6.4 Key Challenges

Even though blockchain technology has the potential to deliver great savings by providing operational efficiency and generating value via new business models, considerable challenges must be overcome before it can achieve conventional adoption.

First of all, achievement of *industry adoption* is the most critical obstacle, and this will define the success of blockchain technology in logistics. The most significant advantage of this technology is being able share information in the most accurate and secure way within a community in which stakeholders benefit even more once it contains multiple important participants. As a result, the value of the community also improves once it is adopted by an increasing number of relevant stakeholders. In another words, as more and more supply chain stakeholders participate, blockchain becomes more valuable, evolving into an industry practice.

However, at first it is always difficult to obtain stakeholder commitment in such advanced technology due to differing levels of digital readiness and the initial requirement to recognize the mutual benefits of blockchain-based collaboration.

Another challenge is the development of standards and governance of blockchain in each industry. There will probably be not just a single blockchain-based system in the logistics industry; instead, there will likely be multiple private permissioned blockchains because of the competitive nature of business. Once there will be multiple public blockchains in the future, organizational bodies will be required to define common standards and agreements, especially in the context of interoperability between blockchains. In order to overcome this challenge, the first blockchain consortia the Blockchain in Transport Alliance (BiTA) has emerged in logistics industry.

The existing technological limitations within blockchain cannot be ignored to make progress. This is especially required for companies moving from a pilot implementation to full-scale deployment. For example, some blockchain implementations have been known to scale poorly and suffer from high latency although new innovations are being developed to address these scalability and performance issues. In some specific applications (such as large-scale, public cryptocurrency networks) there are issues with energy consumption and computing power requirements. These obstacles will need to be addressed for blockchain to reach maturity.

The culture of organization plays a significant role in the success of digital transformation in any industry. The adoption of blockchain technology in logistics industry requires particularly a collaborative mindset to engage with a large number of stakeholders. Therefore, within organizations, a culture of embracing new opportunities from

blockchain technology should be motivated. Managers in IT functions must gain blockchain expertise to proactively push organizational exploration and, if applicable, adoption of blockchain-based solutions.

Across organizations, stakeholders need to engage in shared governance, defining roles and answering key questions (e.g., on process transformation, development of the solution, active versus passive participation). Companies should therefore embrace concepts of collaboration and cooptition in order to derive the greatest benefits from a blockchain transformation.

While there are many issues to overcome, these challenges with blockchain are not impossible to find solutions. Despite its relative infancy, is already showing promise across a wide range of industries including citizen services, retail, life sciences and healthcare, automotive, manufacturing, energy, and logistics. The next section explores how the start-ups are integrating blockchain into their digital logistics marketplace to disrupt the market while exploiting new business model opportunities.

6.5 CASE STUDY: SHIPCHAIN

To demonstrate the main features and advantages of the blockchain-based decentralized marketplaces over centralized traditional marketplaces, ShipChain is chosen as a case study. California-based ShipChain is a start-up that aims at resolving the most common problems facing the logistics industry today by leveraging blockchain features to its track-and-trace platform which is integrated with clients' entire supply chain.

Tracking & Transparency

ShipChain is a decentralized blockchain based marketplace with additional layer of transparency that was previously nonexistent in clients' systems. The capabilities of shipment tracking across the Ethereum blockchain to track individual encrypted geographic waypoints across each smart contract is enhanced by using its sidechain and made accessible for interpretation by only the parties involved.

The company plans to work with the best Electronic Log Device (ELD) developers to provide Track & Trace technology, which will introduce the largest network of trucking freight companies in US, giving the platform a full network of freight movement without the difficult requirement of connecting to individual freight companies (or even individual Owner-operator trucks) one by one.

Track & Trace technology enables better visibility across their supply chain for shippers and allow carriers to communicate with ease while reducing delays and miscommunications. All information related to shipping, location, and basic compliance details will be recorded and publicly validated within the sidechain. After the conclusion of delivery and confirmation, the contract will be completed and recorded on the main blockchain, releasing any payment escrow.

Additionally, it gives opportunity to integrate with the major US railroads, global ocean freight providers, and major airlines to connect at once and create a multimodal blockchain-based tracking system.

The initial step is planned to unify the internal tracking of each carrier with their internal confirmations being fed to the blockchain. Furthermore, the carriers will be assisted with the replacement of their base internal tracking with the Ship Chain system, allowing a greater level of visibility across all of their multimodal shipping partners.

Asset Security

Deploying blockchain technology into the freight industry to encode geographic data will increase cargo visibility by dramatically decrease theft. Assets can be automatically verified every time electronic logs are reported by using barcodes system or hardware RFID integration. With ShipChain's track-and-trace platform, logistics companies can track the entire history of a shipment; therefore, if something goes wrong or there are instances of fraud or theft, supply chain executives can easily locate where in the supply chain it happened and where accountability must be placed.

Decentralized Brokerage and Unified Management

In the current system, freight brokers load, mark them up, and sell them to a carrier, which increases the cost of shipping and reduces profits for carriers and their crew. The Ship-Chain blockchain will supplant the need for brokers by allowing carriers the ability to find shipments and intelligently route their team for multimodal transportation based on factors such as distance, traffic, weather conditions, fuel use and more. This load system will generate a smart contract upon pick-up and will hold payments in escrow until conditions for release are met while using the main blockchain and side-chain for tracking and cargo security monitoring.

7 Conclusions

The success factors of highly fragmented logistics industry have been efficiency, standardisation and low cost until the rise of digitalization. Uber and similar on-demand capacity sharing platforms has fostered the creation of technology-enabled freight marketplaces that basically match shippers and carriers, providing visibility on the information rates, and additional services from different providers in order to enable solutions that better meet the needs of each stakeholder.

Traditionally shippers are reliant on intermediaries such as brokers and freight forwarders since many years. However, there were many inefficiencies within their time and money consuming methods.

Digital freight marketplaces present the biggest disruption in sector within the development of 'sharing economy' capabilities. They aim to position themselves to provide better customer experience with almost no physical assets and purely relied on IT solutions, taking over the role of traditional intermediaries. This results in status quo challenge with the increased competitiveness in the industry, threatening the traditional business model.

The disintermediation model empowered by digitalization introduces three main changes in the industry; increased transparency, shorten time and paperwork elimination. First of all, these digital platforms enable direct communication between shippers and carriers, eliminating the need of middlemen. The opportunities of direct contact help speed up the entire processes, reducing the time wasted in obtaining price proposals and negotiations as in traditional methods.

Secondly, these platforms might save considerable amount of cost considering the fact that traditional staff will no longer have to dedicate time for transactional or contractual negotiations with logistics service providers. As mentioned before, brokers charge a commission up to 20% for the same matching capabilities, while utilizing digital freight marketplaces result in saving the money that used to be paid to middleman. Additionally, many companies still use paper-based methods to record important transactions that can be easily modified and therefore become unreliable. Instead, the online marketplaces reduce this traditionally time-consuming paperwork by providing space where all the

important documents and listings such as a bill of lading, packing list or invoices can be found easily in few seconds.

These solutions also help carriers with document automation, fleet management systems, and guaranteed payments within 24 to 72 hours. Moreover, empty miles problems of truckers can be reduced within the digital marketplaces by enabling greater load efficiency which consequently lowers fuel costs and lesser greenhouse gas emissions.

Finally, there are other provided functionalities to increase customer experiences. For example, shippers can benefit instant quotes with the opportunity to compare rates and carriers, and transparent pricing.

Online platforms also enable automated tracking of the shipments through notification system. Thus, customers are able to track their shipments without the need of communicating with customer services. In addition, customer care services are also available on these platforms anytime customers need.

Despite all the advantages mentioned above, there are still existing challenges with the current digital freight marketplaces. The most significant issue is the concerns related to trust and data security. Meanwhile, the blockchain-based decentralized marketplaces ensure privacy and security for transactions while facilitating trust among all participants. Thus, it can be a way to overcome such challenges, benefiting from the capabilities of disruptive blockchain technology.

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