The Blockchain Technology
Applications to the Maritime Logistics

Alessio Tei, University of Genoa
Newcastle upon Tyne, 20th February 2020
The agenda

• Background
• Why Blockchain?
• A review of the blockchain concept
• The future of “maritime” blockchain
Background

• Shipping has been often defined as a conservative industry (e.g. Stopford, 2009; Stott, 2017).

• Reasons of the business “aversion” to innovation are normally linked to:
  • Shipowners’ speculative behaviour
  • Use of the ships
  • Market volatility and instability
  • “Interoperability of vessels”

• The abovementioned elements generate potential barriers to innovation that could increase the costs of “improving” vessels or their management

All of these elements are partially different for port operators since they can directly enjoy the benefits of innovating (e.g. automation, new cranes, layouts, etc.)
Barriers to innovation

The speculative behaviour
• Most of the ships are sold many times during their life-cycle. Thus, there is not actual advantage for a shipowner to intervene on an existing ship if there is no compulsory need: this represents an innovation barrier

Use of the ships
• Most of the ships are actually charted or on lease and the owning company is normally interested in having a vessel able to be «sold» in different markets: this often represents an innovation barrier
Barriers to innovation

**Market volatility**
- Innovations are costly and they normally represent a long-term investment: the shipping market sudden changes often represent a barrier to innovation

«**Interoperability of the vessel**»
- Most of the vessel needs to be able to operate on different markets (e.g. port facilities, environmental characteristics), ship specificities and specialisations might represent an innovation barrier
Is the Maritime Industry innovative?

- Policy papers (e.g. ITF, 2010) and many other academic studies would say no but:
  - Flettner rotors
  - Autonomous vessels
  - Scrubbers
  - Blockchain

..And many more could come..
..what’s the issue then?
The innovation concept

• According to Thanopoulou (2010), innovation concept includes both organizational and technological factors and is defined as ‘the new uses and/or combinations of already existing resources brought about by changes in technology and/or organization’

• Given the abovementioned definition, while radical innovations (e.g. container) are rare in the shipping sector, other “modular” innovations are relatively common (e.g. Acciaro et al., 2018):
  • Within the radical changes we can list:
    • Containerisation,
    • Autonomous vessels,
    • Blockchain
  • Within the modular category we can list:
    • New bunkers,
    • Mega-vessels,
    • Ballast water treatment systems

• These different “innovations” follow different development patterns and achieve unexpected goals (e.g. “slow steaming”)
Is it convenient to innovate?

- Innovation has always been an appealing concept but:

- Similar issues happened in the port and maritime sectors:
  - Several strikes characterised both shipbuilding industry and the port industry in order to avoid the inevitable:
    - Labour force changes
    - Cranes
    - “Automation”
  - This impacted both productivity and employment rates
    - E.g. a medium sized ship was capable of being operated in minimum a week until the ‘90s. nowadays, it is a matter of a few days top.
    - Employment rates drastically fell: most of the ports now have less than 50% of the employees that had until the ‘90s.

Do you remember what this “little thing” is?

Do you remember what were they doing?
What is a blockchain?

- The main concept of *blockchain* has been developed in the ’90s in the informatics industry but the term *blockchain* has been used for commercial purposed only around mid ’00s with the first discussions about cryptocurrencies (e.g. bitcoin)
  - The blockchain concept incorporates several theoretical backgrounds, it is based on cryptography and informatics, but it is shaped in order to serve applied fields, such as banking, logistics, marine transport, and the public administration services

- From a general point of view, blockchain “...*enables creating a tamper-proof ledger shared by multiple stakeholders that can have competing interests and, therefore, that do not trust each other as the only source of information. In this way, the different stakeholders can use blockchain systems to create records in a secure, trustable and transparent manner...*”

Thus the blockchain is a «tamper-proof ledger»
Why Blockchain?

Kodak announces its own cryptocurrency and watches stock price skyrocket

Kodak stock jumps 60 percent after the surprise announcement

By Shannon Liao | @Shannon_Liao | Jan 9, 2018, 3:22pm EST

And then...why blockchain?

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Why blockchain?

Can you imagine doing these operations manually?

Blockchain is meant to solve similar issues with logistics and port admin operations, potentially linking systems that today already exist.

More risks, more time needed, more people involved, More checks

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How does the blockchain works?

A blockchain is a decentralised system that allows the users to exchange information in a way that all local users «own» the information on the additions and modifications of new «blocks» and all these actions need an «authorisation» in order to guarantee the security of the system. This approach should lead to:

- Reduced cybersecurity risk
- Increased trust

Within the same chain, not all the different blocks have the same rights (i.e. access the same info or can do the same activities)
Blockchain and advanced services

• The term blockchain is normally associated to:
  • Virtual transactions
  • Introduction of smart-contracts
  • Digitalisation of admin operations
  • Documental controls and reduction of paper-based documents
  • Reduction of cargo checks

• These «advantages» might directly impact on the shipping and port intermediation activities not on the main traditional «activities» (i.e. the transport of goods)
Blockchain applications

- So far only test beds have been developed at shipping level.
- Nevertheless many public administrations have started to implement some admin services based on blockchain.
- Examples can be found in:
  - Some states of US
  - UAE
  - Banking
- Within the shipping sectors, the blockchain concept started to circulate 5 years ago:
  - In 2014 Maersk has recorded that in many of its services one third of the trip time was actually linked to documental and admin controls, with several operators involved in such activities. This lead the company to start planning alternative solutions

The goal is to achieve a 20%-30% savings in both time and costs, along the overal supply chain and 15%-20% savings in port related activities

Maersk evaluated the interactions for sending a box from Kenya to Rotterdam in: 30 different companies, 100 people and more than 200 documents exchange. Everything would be drastically reduced with the blockchain system.
Some key questions

• Despite the potential high impact of the blockchain technology on the shipping industry, it is interesting to notice that not many studies are currently assessing the implementation of such technology on the shipping business and not many applications are actually on the market yet.

• Thus, a few important questions are worth to be addressed:
  • What might be the effect of the blockchain technology on the shipping business?
  • Which barriers need to be tackled?
Why resisting?

• In every market change there are hidden costs connected to the network management, the interoperability, and to the needed new skills.

• Moreover, who benefits the most might not be the same market actor that were enjoying previous competitive advantages:
  • Innovator leader
  • Inter-Generation gap

Further frictions might be related to:
- Legislation restrictions
- Business challenges and power shifts

Solutions are possible but they imply extra-costs....

New job descriptions

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Some key questions

• Given the impossibility to collect proper statistics on the phenomenon under investigation a **triangulation approach** has been used.
  
  • **Web research** – to understand current industry practice
  
  • **Desktop research** – to understand current (academic) knowledge and its linked to the market development
  
  • **Survey** – to validate results and better understand main stakeholders’ views
Desktop Analysis

• Using the database Scopus, 37 papers have found answering the queries:
  • “blockchain AND shipping”
  • “blockchain AND maritime”
  • “blockchain AND ports”

• All these papers have been published within the period 2017-2019
  • Only 18 papers are actually discussing blockchain in the shipping market and they do not just use the shipping sector as example of future applications:
    • Currently the topic is definitely understudied!
Desktop analysis: findings

• The relative recent interest on blockchain in shipping, make the overall assessment of the initiative quite difficult. Main stream researches are connected to:
  • General implementation plans
  • Effects of blockchain on logistics operations
  • Impact of blockchain on specific shipping services
  • Technical and technological issues
  • Cyber treats and legal issues

• The blockchain is seen as a major game changer but with different potential frictions in its implementation, mainly based on:
  • The role of different actors
  • Local legislation
  • Actual gain of the promised advantages

Blockchain is:
- a liner shipping issue more than a bulk shipping innovation
- some ports/regions are promoting blockchain solutions while other are creating obstacles
Web-based Analysis

• For the Web based assessment The TradeWinds database has been used.

• Until July 2019, 104 news discussing blockchain related development have been published.
  • While the oldest news on blockchain in shipping dates back to 2016, **2018 registers 50% of all the published news**
  • Moreover, the first 6 months of 2019 the recorded the same number of news of 2016 and 2017 together.

• The chosen industry media source suffered from a polarizing issue: 40% of the news discussing blockchain are considering as main example the Maersk-IBM joint venture (i.e., TradeLens) as main market benchmark, despite only 7 of them are fully focusing on the description of the system itself.

The web-based research allows to assess the projects currently presented to the market at either test phase or with some initial commercial activities.
The impact of registering delays..

Taking the lead is crucial but multiple failing stories also justify uncertainty on blockchain.

2007 (The Iphone..)

The new technologies allowed the development of a mass service related industry (e.g. social media) that without the new generation of phones would not exist..

But also other industries started to struggle.. As in the case of photography or old mobile companies..

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A more “applied” view..

• Among the 20 major projects currently under development:
  • 50% of them relate to the management of cargo along the entire supply chain (e.g. TradeLens, SOLAS VGM, EverLedger, Provenance) while the others are focusing on the optimisation of just specific elements, such as the bill of lading and the management of smart contracts
  • Interestingly, the strict majority of the blockchain initiatives are not dealing with payment issues (despite the potential link to cryptocurrency)

• Most of the ongoing projects seem to have as aim the reduction of the intermediation phases

• From a geographical perspective, 60% of the highlighted initiatives base their operations in Europe with another third based in Asia
  • Despite this, the main technological developer is US based
Some examples

<table>
<thead>
<tr>
<th>Company</th>
<th>Focus</th>
<th>What’s the Problem?</th>
<th>What’s the Solution?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blockfreight</td>
<td>Complete shipping blockchain</td>
<td>Fragmented IT systems with limited interoperability</td>
<td>A complete blockchain for shipping, with built in cryptocurrency token</td>
</tr>
<tr>
<td>Wave BL</td>
<td>Bill of Lading</td>
<td>A negotiable BL serves as receipt, contract of carriage and title of goods. Currently mainly analogue</td>
<td>Blockchain application allowing for sharing of BL data and anonymous trading of BL</td>
</tr>
<tr>
<td>Maersk; IBM</td>
<td>Documentation pipeline</td>
<td>Over 30 different documents are needed to process an export consignment across multiple supply chain steps</td>
<td>Shared blockchain based repository (i) making the needed documents only visible to the parties required to see them and (ii) tracking and time-stamping changes in the chain of custody of a shipment</td>
</tr>
<tr>
<td>Port of Rotterdam; ABN AMRO; Royal Flora Holland; TU Delft; and more</td>
<td>Trade finance</td>
<td>Cumbersome letter of credit process involving banks in both source and destination countries</td>
<td>Self-executing smart contracts triggering payment on proof of delivery</td>
</tr>
<tr>
<td>SKUchain</td>
<td>Trade finance</td>
<td>Cash flow issues related to the current trade finance process</td>
<td>Smart contracts. So-called ‘brackets’; blockchain-based release of funds that are conditionally key-signed and triggered by signals</td>
</tr>
<tr>
<td>Everledger</td>
<td>Provenance and traceability</td>
<td>Origin of products is unknown for end user</td>
<td>Blockchain application for tracing diamonds</td>
</tr>
<tr>
<td>Provenance</td>
<td>Provenance and traceability</td>
<td>Because of obscure supply chain, many companies are unable to display the origin of their products to customers</td>
<td>Open blockchain-based traceability platform</td>
</tr>
<tr>
<td>SOLAS VGM/MTI</td>
<td>Verified gross mass of containers and data sharing</td>
<td>VGM data must be forwarded ahead of time to the carrier. Currently using EDIFACT Alessio Tei - Newcastle February 2020</td>
<td>Application for recording container data upstream (load points and weighbridges) on a distributed ledger. Interoperable with EDIFACT and API</td>
</tr>
</tbody>
</table>

Source: own elaboration from NEPIA, 2019
The market leader

### TradeLens in early 2019

<table>
<thead>
<tr>
<th>Terminal Location</th>
<th>Operator</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeciras, Spain</td>
<td>APM Terminals</td>
<td>☑</td>
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<tr>
<td>Apapa, Nigeria</td>
<td>APM Terminals</td>
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<tr>
<td>Auckland, New Zealand</td>
<td>PortConnect</td>
<td>☑</td>
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<tr>
<td>Avonmouth, UK</td>
<td>MCP</td>
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<tr>
<td>Bahrain</td>
<td>APM Terminals</td>
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<tr>
<td>Bilbao, Spain</td>
<td>Port of Bilbao</td>
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<tr>
<td>Brisbane, Australia</td>
<td>Patrick Terminals</td>
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<tr>
<td>Buenos Aires, Argentina</td>
<td>APM Terminals</td>
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<tr>
<td>Busan, South Korea</td>
<td>Port of Busan</td>
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<td>Callao, Peru</td>
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<td>Cotonou, Benin</td>
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<td>Felixtowe, UK</td>
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<td>Fremantle, Australia</td>
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<td>Gothenburg, Sweden</td>
<td>APM Terminals</td>
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<td>Halifax, Canada</td>
<td>Halterm Canada</td>
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<td>Hong Kong</td>
<td>Modern Terminals</td>
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<tr>
<td>Houston, TX USA</td>
<td>Port of Houston</td>
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<tr>
<td>Itajaí, Brazil</td>
<td>APM Terminals</td>
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<td>Izmir, Turkey</td>
<td>APM Terminals</td>
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<td>La Paz, Mexico</td>
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<td>Liverpool, UK</td>
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<td>Los Angeles, CA</td>
<td>APM Terminals</td>
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<tr>
<td>Maasvlakte II, Netherlands</td>
<td>ICTS</td>
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<td>Patrick Terminals</td>
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<tr>
<td>Melbourne, Australia</td>
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<td>Montreal, Canada</td>
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<td>Napier, NZ</td>
<td>Napier Port Authority</td>
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<td>Newcastle, UK</td>
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<td>Oliva, Nigeria</td>
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<td>Philadelphia, PA USA</td>
<td>Packer Terminals</td>
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<td>Pipa, Brazil</td>
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<td>Port of Rio de Janeiro</td>
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<td>Rotterdam, Netherlands</td>
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<td>Sydney, Australia</td>
<td>Patrick Terminals</td>
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<td>Singapore, Singapore</td>
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<td>Teesport, UK</td>
<td>MCP</td>
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<td>Valencia, Spain</td>
<td>Port of Valencia</td>
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<tr>
<td>Visakhapatnam, India</td>
<td>JM Boxi</td>
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### Ocean Carriers

<table>
<thead>
<tr>
<th>Ocean Carrier</th>
<th>Status</th>
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<tbody>
<tr>
<td>Maersk Line</td>
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<td>Hamburg Sud</td>
<td>☑</td>
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<tr>
<td>Pacific International Lines</td>
<td>☑</td>
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<tr>
<td>Boluda Lines</td>
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</table>

### Live

The Network Member is connected to the Platform and providing data.

### In Process

The Network Member engaged in/or integration is in process.

Some members engaged under Early Adopter Program and/or trial agreements.

### Authority

- Australia Home Affairs
- Bahrain Customs
- Canada Customs
- Dutch Customs
- Ghana / GCNET
- Saudi Arabia Customs
- Peru Customs
- Singapore Customs
- Turkey Customs

### Source

Source: own elaboration from IBM, 2019

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Desktop & Web-based analysis: findings

• Currently, several actors are trying to develop their own blockchain, forming different consortia. Among these groups all the main shipping companies e.g. (e.g. APL/CMA- CGM, Maersk, HMM, COSCO) and port actors (e.g. PSA, Port of Rotterdam, Hutchinson) are involved

• Currently, there are several industrial projects but only really few scientific researches on blockchain in shipping, thus most of the conceptual framework is developed through industrial research
  • Or through marketing strategies

• All these projects are quite different from each other and do focus on different strategic elements (e.g. documents, admin, costs, payment method, operation planning), affecting their implementation strategies:

• Thus, each blockchain has:
  • Its own characteristics, goals, and specificity
  • Different standards and uses different software platforms
  • Possibility to provide different services or to be access by different actors

A problem of standard arise: in 2019 most of the major companies have all joined TradeLens
An initial survey

• During spring 2019 a survey has been circulated to different experts.

• Information from four categories of maritime stakeholders has then been collected:
  • Port authorities
  • Shipping companies
  • International organisation dealing with trade
  • Experts involved in industry research on blockchain solutions

• Given the low response rate, informal interviews have been carried in order to increase the reliability of the preliminary findings coming from the survey
The survey’s findings

How would this impact the port and shipping business then? Is blockchain really happening?
Concluding remarks

• The blockchain theoretical advantages could be unprecedented for an IT solution applied to shipping (e.g. 25% of cost reduction, 40% of reduced delivery time) and this attracted the attention of the industry rather than traditional academic studies

• Several frictions are still present on the market, with local actors and regulators that are not currently fully on board of the different initiatives
  • The promised efficiency gains are often connected to border controls, implying that local factors have actually a great role in the implementation of the blockchain
  • Public administration seems to prefer a neural role (lock-in effect) and this is slowing down the innovation implementation
  • Specific sector related pushes are also affecting the blockchain implementation that is particularly successful for certain supply chains

Uncertainties due to “systemic” innovation development patterns

This does not mean the blockchain solutions are not present...