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Challenges and Opportunities of Big Data Analytics for Maritime and Shipping Industry

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ABSTRACT
Big Data is more than just large amounts of data. Big Data allows companies to use enormous amounts of data from non-traditional sources. A non-traditional source is time-sensitive data, not just past recorded data, used to optimize the industry and ports. Big Data includes texts, audios, videos, and real-time information. Big data is a big category which includes the data in both structured and unstructured forms stored in the cloud. For e-commerce, the supply chain data source might be order management systems, warehouses, payroll, inventory systems and carrier data. For the Maritime analytics market traditional data may come from dockyards, ships, vessel operations, bill of lading, traditional (fixed) data is used to analyze profits and losses. Nontraditional is time sensitive and not always quantifiable. Examples of nontraditional data are weather data, traffic and location data and movement of freight via transportation
Keywords: Maritime, Shipping, Big data Analytics, Digitalization.

Introduction

Big Data in Maritime: How a shipping company can effectively use data

Before the appearance of big data, associations used traditional technologies to dissect large datasets collected from conventional sources similar as warehouses, distribution bumps, etc. Still, with the appearance of big data, it has come easier to perform. Analytics not only consists of large data sets coming from traditional sources but also takes into account and analyzes unconventional data in real-time bumps, as well as in batch mode. There are several vital uses of big data in the shipping and logistics assiduity. Thanks to the use of big data engineering, shipping assiduity has grown indeed stronger over the formerly multitudinous times. Big data is used to manage boat detectors and for prophetic analysis, which is demanded to help detainments and lessen the overall functional effectiveness of the assiduity. In shipping assiduity, proper weight shadowing is essential to insure the necessary safety and confidentiality. Through data attained through proper shadowing of shipments several times, information on the causes of vessel losses at the ocean, losses of holders inside or outside stations or storages, and other problems related to dispatch(for illustration, the reasons for damage to the goods) may be entered. This big data for the shipping assiduity can be used to make opinions in the future to prognosticate and avoid precious problems and to produce farther dependable weight delivery options. Everyone agrees that big data can play an important part in boat design. This will be possible by assaying the results obtained from the detectors of preliminarily used vessels. Data collected and anatomized over the life of the vessel will be useful for unborn advancements in boat design. former datasets could help in testing the proposed boat design without physically developing it. This is a truly big advantage for the shipbuilding assiduity. As we move towards a farther globalized frugality, the demand for transportation of goods and related logistical support will continue to grow exponentially. Over time, this growth will increase the need for maximizing time and profitability to have the most profitable delivery processes. Through the use of

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advanced data recovery ways, the delivery of goods will become more effective. More transport services will increase overall transnational trade.

Literature review

Big Data in Complex Systems-Challenges and Opportunities, Springer, London, 9 (2015) states challenges and opportunities of Big Data in Complex Systems State of the art and in-depth material on the application of Big Data in complex systems.It also presents new aspects of efficient processing of massive data and knowledge discovery from large database.

Literature on Data driven business models: challenges and opportunities of Big data,University of Oxford (2014).

This report draws on interviews with 28 business leaders and stakeholder representatives from the UK and US in order to answer the following questions: How is (big) data being used; what is a 'big data business model'? What are the main obstacles to exploitation of big data in the economy? What can and should be done to mitigate these challenges and ensure that the opportunities provided by big data are realised?

In BIG Data Related Technologies-Challenges and Future Prospects, Springer, London, 2014. the following were found.

- Data Representation:
- Data Life Cycle Management:
- Analytical Mechanism: the analytical system of big data shall process masses of heterogeneous data within a limited time.
- Data Confidentiality:. Therefore, analysis of big data may be delivered to a third party for processing only when proper preventive measures are taken to protect the sensitive data, to ensure its safety

Big data application in the marine industry:

Ship Operator : Operator,Energy saving operation,Fleet Planning,Fleet allocation,Service planning

Ship owner: New building,Design Optimization,Technical Managemen,tSafe operation, Hull and Propeller cleaning

Chartering:

At the heart of chartering lies the mission to discover the perfect vessel for cargo, achieving the delicate balance of optimal performance at the most economical price. This task, heavily reliant on insights from trusted brokers and ship owners, often encounters limitations in terms of efficiency due to the inherent constraints of available information.

Enter the realm of big data analytics, a transformative force ready to equip charterers with a wealth of readily available, precise, and actionable information to elevate their decision-making prowess. By seamlessly integrating Automatic Identification System (AIS) data, position reports, estimated arrival times, vessel specifications (including size), and market dynamics into a cutting-edge exchange portal, charterers unlock a treasure trove of alternatives and gain a comprehensive freight forecast.

This innovative approach not only expands the array of options available to charterers and ship owners but also infuses the chartering landscape with enhanced transparency and heightened competitiveness. It's not merely about finding the right ship; it's about navigating the seas of choice with finesse, ensuring charterers and ship owners alike have access to a spectrum of possibilities that illuminates the path to optimal efficiency and economic advantage.

Operations:

In the intricate world of maritime operations, vessels, akin to motorcars, possess a sweet spot – an optimal speed that balances performance and energy efficiency. During the delivery phase, vibrant tests are orchestrated, resembling a symphony of colors, to pinpoint the precise speed that maximizes

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energy conservation. Navigating this optimal speed is akin to a delicate dance, evolving over time due to a myriad of factors such as machinery wear and tear, and conscientious conservation efforts.
Here enters the transformative force of big data analytics, a technological virtuoso poised to empower boat owners in the dynamic realm of speed optimization. Beyond the conventional metrics, big data analytics becomes the compass guiding boat owners to ascertain the perfect speed for energy consumption. This analytical prowess doesn't just consider vessel dynamics but elegantly incorporates variables like storage costs, prevailing freight rates, and intricate schedules.
This innovative approach transcends the mundane, offering boat owners not just a speed but a tailored solution that aligns with the nuanced intricacies of cellarage expenses, freight dynamics, and operational schedules. It's not merely about finding the optimum speed; it's about orchestrating a maritime performance tuned to the symphony of factors that define efficiency and economic viability.

Maintenance:
In the realm of vessel maintenance, pivotal decisions concerning tasks such as hull cleaning and propeller polishing often rely on intuition or adherence to predetermined schedules rather than being grounded in the tangible performance of the vessel. This conventional approach lacks the precision required for optimal efficiency. However, by leveraging fuel consumption data, a profound shift can occur, enabling a meticulous cost-benefit analysis of vessel maintenance practices.
The transformative power of data analytics emerges as a guiding force, streamlining the decision-making process for operators. Instead of relying on mere intuition or rigid schedules, fuel consumption data becomes the cornerstone for informed choices. This analytical insight not only aids in determining the opportune timing for maintenance efforts but also unveils the tangible benefits derived from these practices.

Voyage operations:
In the intricate world of terminal operations, the imperative for accurate Estimated Time of Arrival (ETA) and cargo information is indispensable for terminal operators, voyage managers, and port agents. The conventional reliance on notes, emails, or phone calls gives way to the dynamic capabilities of dashboards, offering real-time tracking of vessels. This not only revolutionizes communication but also enhances decision-making regarding terminal and berth allocation, cargo handling, and route monitoring.
The significance of dashboards is further underscored by their ability to reveal deviations from optimal performance. They become a vigilant eye on the entire voyage, offering insights into the ideal route, the route suggested based on weather services, and the factual route being pursued.
Vetting:
Vessel owners and operators go beyond merely ensuring the adequacy of their fleets; their aim is to make them not just acceptable but exceptional for use by discerning charterers.Rather than singularly focusing on enhancing vessel quality, their strategic emphasis lies in aligning with and surpassing acceptance criteria. This meticulous vetting process is a holistic endeavor that involves soliciting feedback from a diverse array of entities, including inspectors, terminals, port state authorities, and the invaluable self-assessment of operators.
In this era of smart vetting, data analytics isn't just a tool; it's a strategic asset that propels the maritime industry into a realm of precision and efficiency. By harnessing this technology, charterers and vetting organizations navigate the seas of information with finesse, ensuring that the selected vessels stand as paragons of excellence in every aspect, setting a new standard in maritime quality assurance.

CHALLENGES/ ISSUES

Cyber threats:
Marine IT and telecommunication infrastructures are at high risk of penetration from cyber criminals, terrorists or other malevolent interests. According to CyberKeel, a Danish cyber security firm, more than 90% of the largest container lines are vulnerable to hackers.

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ESC Global Security's head of cyber security division, Joseph Carson, also mentioned that big data will increase the vulnerability to cyber-crime in the maritime industry. There is the potential for a major cyber-attack on the maritime industry, which may lead to disruption in food and energy supplies, as shipping transports 90% of the world's total trade.

Misreporting of data

Misreporting of data can cause concerns, as it may lead to incorrect analysis and inappropriate decision-making.

Slowdown in investment in big data analytics due to existing challenges

The shipping industry has been facing numerous disturbances and challenges such as market fluctuations, over supply, margin pressures and labor shortages. These challenges are expected to impact the industry's profitability. According to a report published by IHS in November 2015, in the coming 5–10 years, the industry will experience slow growth. In such an unstable environment, players are uncertain about implementing big data as it is a relatively new technology in the industry. As a result, investments by these companies in big data analytics technologies are decreasing.

Lack of cross-enterprise technology implementation

Currently, ship builders, ship owners and ports are solely focusing on running reasonably efficient operations and not on running a highly flexible, responsive trading business of 'container-as-a-community'. This means that there is a lack of cross-enterprise processes. Companies are concentrating on automating processes within functional silos instead of taking a holistic view of the enterprise. This prevents the true potential of big data from being realized.

Lack of big data-skilled workforce / Skills shortage

Ensuring enough quantity and quality of human resources is essential for developing the use of big data solutions for maritime. There is a shortage of highly trained data scientists. This shortage is expected to further increase in the future.

In Marine Digital we work with Big Data - we collect and process it. We have created a tool that collects data from vessel's sensors, as well as from external sources such as weather stations, satellites, etc. We process the entire data array through machine learning algorithms in order to provide the shipowner and the management of the shipping company with the necessary information for making decisions, such as, for example:

When the hull from fouling should be cleaned in order to spend less fuel?

When engine and equipment parts on the ship should be changed?

What is the best route in terms of weather, safety and fuel economy?

for the questions like above can be answered by using Big data applications for the data we stored from the others ships and voyages.

OPPORTUNITIES

- Predictive Maintenance:

  Predictive maintenance emerges as the beacon of innovation, offering a departure from traditional reactive approaches. By leveraging big data analytics, maritime stakeholders gain a holistic understanding of vessel health, enabling the anticipation of potential failures before they occur. This proactive stance minimizes downtime, slashes maintenance costs, and ensures optimal operational performance.

- Route Optimisation:

  Navigating through the sea is highly complex involving route management, facing weather that never stands predictable and optimizing timing for burning fuel – all these have to be approached strategically after harnessing the power of big data which empowers vessels with sentience whereby routes are dynamically changed based on real-time inputs. It ensures the safest and fastest passage

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while ensuring fuel efficiency that aligns with their commitment to sustainability in the industry.

- Fuel efficiency and Emission reduction:
  Big data analytics enables maritime stakeholders to monitor the emissions in real-time ensuring conformity with international standards. Further, it enables organisations to outdo regulatory thresholds, showing commitment not just about compliance but performance above the minimum requirements for environmental responsibility It can assess fuel consumption patterns and suggest ways of using fuel efficiently hence contributing in cost cutting.

- Risk management:
  However, big data analysis changes this paradigm by giving real-time information about potential risks. Maritime stakeholders can anticipate challenges such as adverse weather conditions, route deviations, and equipment failures by analyzing huge datasets to enable them to put in place measures that prevent the escalation of potential risks before they occur.

- Supply chain visibility:
  Traditional supply chain visibility often grapples with delays and uncertainties. Big data analysis, however, propels the maritime sector into the era of real-time cargo tracking. Vessels equipped with smart sensors and IoT devices relay live data, enabling stakeholders to trace the journey of goods seamlessly, minimizing disruptions and enhancing overall supply chain efficiency.

- Cargo handling optimisation:
  With the help of big data analysis, new horizons are emerging in improving cargo handling efficiency for the maritime sector. The industry places itself as a trailblazer in technology applications for operational mastery, with vessels powering through the seas guided by data. In intelligent logistics era, cargo handling gains prominence from just being a process; it becomes the backbone of maritime sector as intelligence guides into future environments where efficiency sustainability and competitiveness are reflected in large scale on our oceans' canvas by enhanced big data analysis giving port operations endow with intelligence that unveils arrivals schedules for cargoes vessels utilization This makes ports operate at full capacity thereby preventing overload and fastens cargo handling processes with accuracy.

- Operational efficiency:
  Traditional operational monitoring is often characterized by delays and uncertainties. Analysis of big data changes operational effectiveness by facilitating real-time performance tracking. Vessels equipped with smart sensors and IoT devices transmit live data to stakeholders who can get instantaneous insights into engine performance, fuel consumption ,and operational health. This not only reduces the downtime but also allows for quick decision-making to make appropriate course alterations.

- Environmental Impact Reduction:
  In many cases, traditional approaches to emission reduction tend to respond after an incident has taken place. However, big data analysis creates a new paradigm by allowing proactive emission modeling. Use of historical data and trends regarding emissions by maritime operators can help them in predicting future levels so that they can make strategic planning, which includes adoption of various mechanisms to minimize the impact on the environment.

- Business Intelligence and Decision Support:
  Resource allocation is an integral part of marine operations. Through big data analytics, operators can derive smart information about how resources are being utilised thereby optimising deployment of crews fuel consumption and maintenance routines. This information management allows for improved efficiency, lowered operational costs and generation of a culture that practices sound resource use within the maritime sector.

- Improved Safe:
  Traditional safety programs tend to function in a reactive mode. The use of big data analysis for

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security, safety protocols improves significantly because such art enables the real-time monitoring. Vessels with smart sensors and IoT devices send live data in real time, enabling all stakeholders to get instantaneous insights into influences like weather conditions or the health of machinery as well as navigation parameters. It not only improves decision making but also facilitates speedy intersessions to ensure safety of both crew and vessels.

- Customer Experience Enhancement:
Customer satisfaction is intricately linked to timely deliveries. Big data analytics facilitates predictive arrival notifications by analyzing historical data, weather conditions, and vessel performance. This proactive approach ensures that customers receive accurate and timely information about their cargo's arrival, enabling better planning and minimizing disruptions in their supply chain.

TABLES / ANALYSIS

Parameters	**Traditional data**	**Big data**
Type of data	Structured	Unstructured
Volume of data	Terabyte	Petabytes and Exa bytes
Architecture	Centralized	Distributed
Relationship between data	Known	Complex

Table 1. Comparison of Big data with traditional data [1]

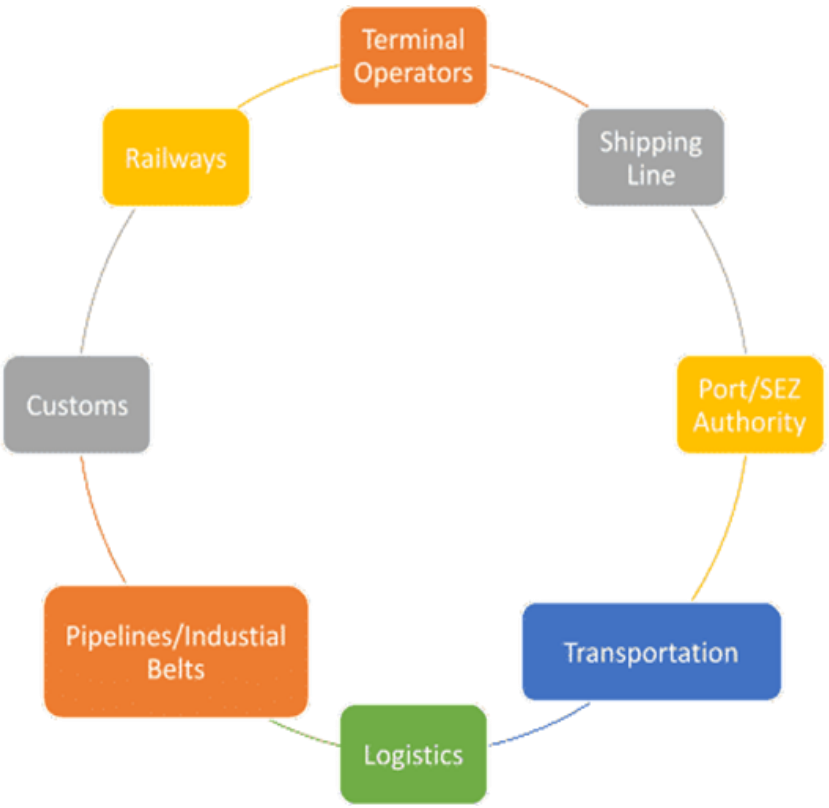

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Table 2. A Smart Port [2]

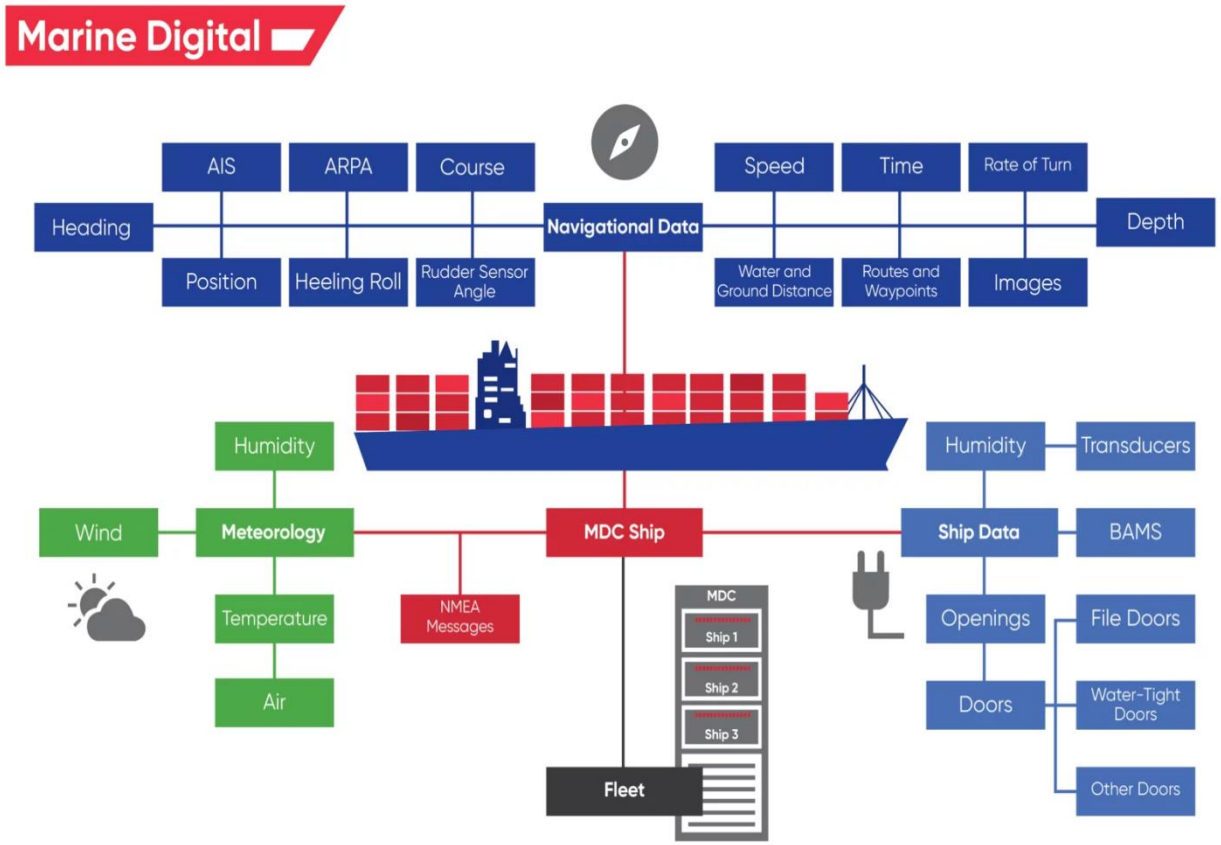

Table 3, Courtesy : Marine Digital

CONCLUSION

The Big data applications will change the maritime industry in the following areas
(1) digital transformation, exploring the impact of digital technologies on business models and operations;
(2) applications of big data from AIS, addressing how data analysis, particularly AIS data, can be applied to improve safety, security, and both environmental/commercial efficiency;
(3) energy efficiency, covering topics such as speed optimisation and route/crane planning; and
(4) predictive analytics, focussing on ship systems maintenance, traffic and accident scenario analysis and other decision making and forecasting challenges.

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