The International Maritime Transport and logistics Conference

Towards Global Competitiveness in Maritime Industry

"INVESTING IN PORTS"

The Trends, The Future

8 2019 Marlog

Developing a Maritime Big Data Management Architecture Using Information Entropy

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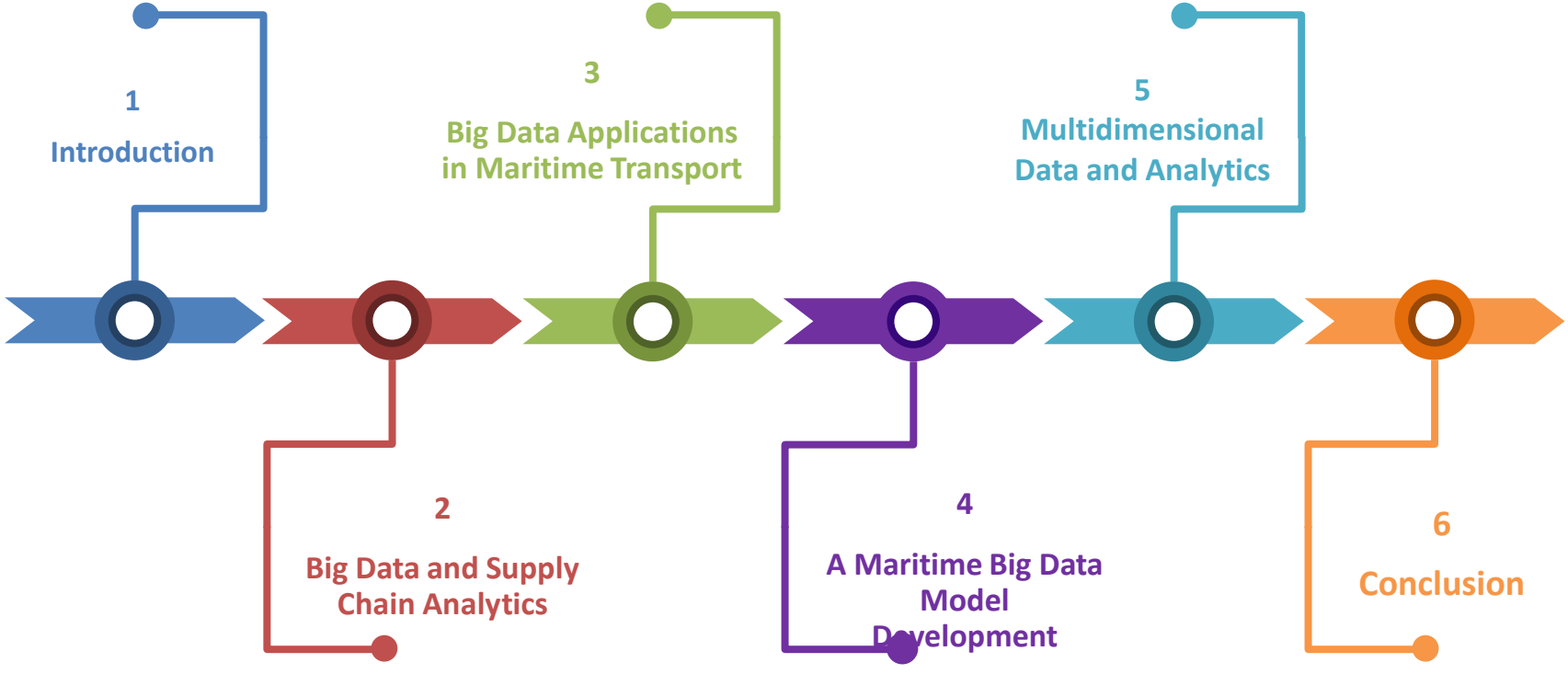
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INTRODUCTION

THE DEATH OF SUPPLY CHAIN MANAGEMENT

Harvard Business Review

- According to HBR, New digital technologies that have the potential to take over supply chain management entirely are disrupting traditional ways of working.
- Within 5-10 years, the supply chain function may be obsolete, replaced by a smoothly running, self-regulating utility that optimally manages end-to-end work flows and requires very little human intervention.

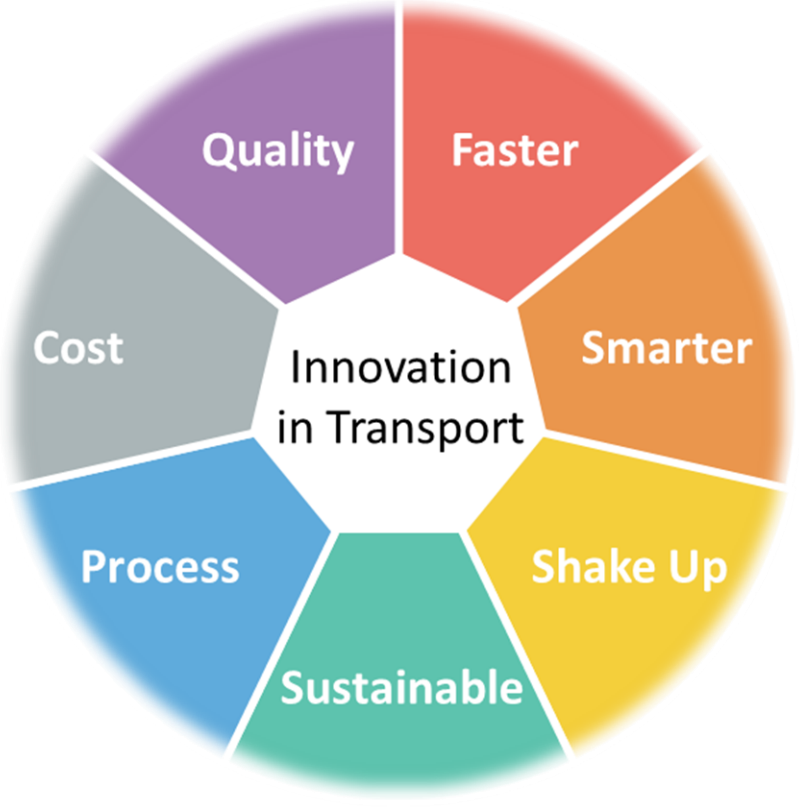
NEW HORIZONS

Most recently, the growth of digital technologies has enabled organizations to collect increasingly massive amounts of data—and, they subsequently require even more powerful techniques to make sense of that data.

INTRODUCTION

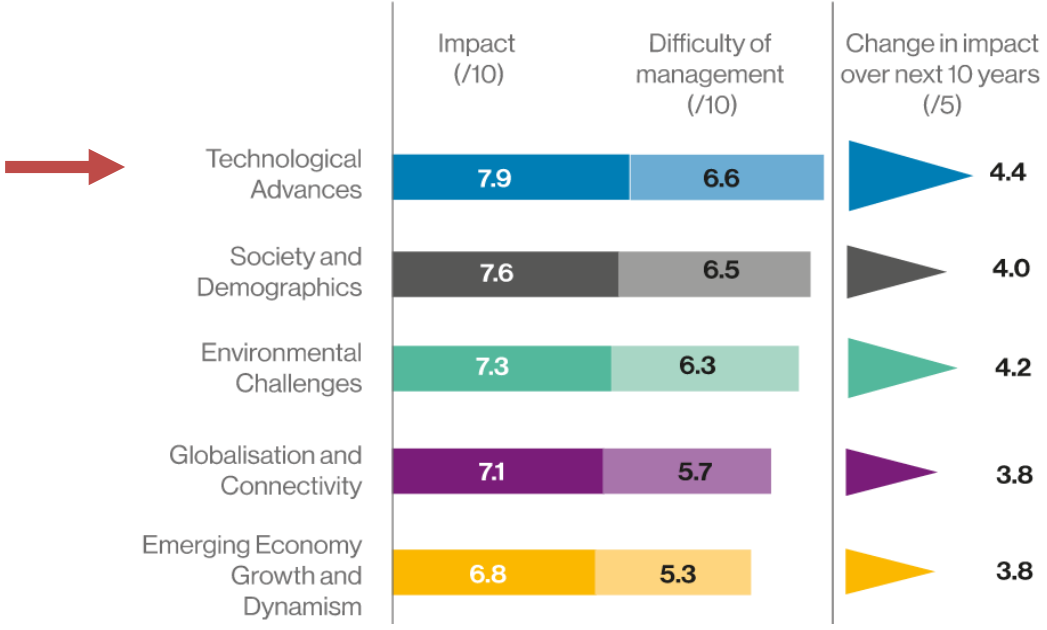
- Transport Industry is currently confronting immense changes and challenges:
  - *The emergence of global logistics service providers*
  - *Flexibility in service offerings*
  - *Relationship with customers*
  - Globalisation of the logistics market
  - *Innovation*
- This brings both risk and opportunity
- Transport Industry could meet these challenges
- There are many ways the industry could develop

INNOVATION CONCEPT IN TRANSPORT INDUSTRY



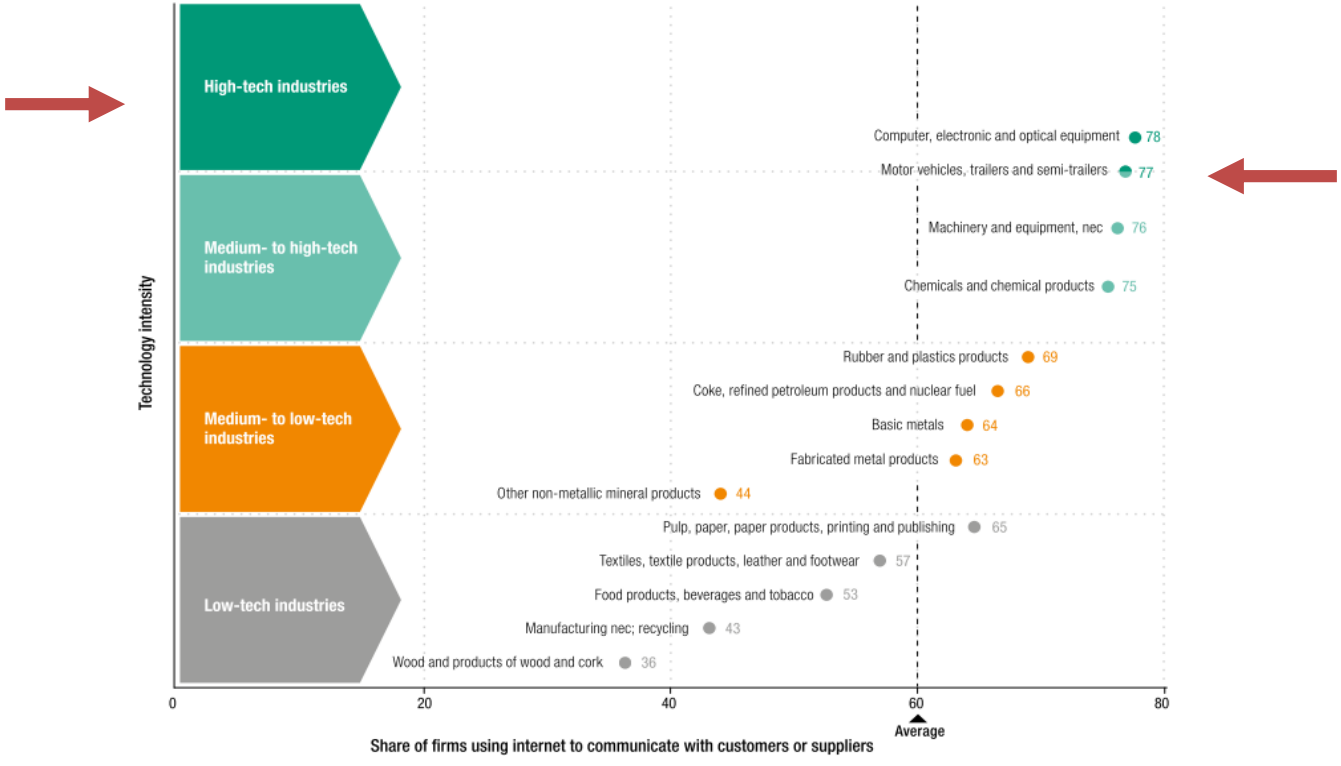
INTRODUCTION

Current Transport and Logistics Innovation Trends



Source: Global Investment Megatrends Report, 2017

INTRODUCTION



Source: World Investment Report, UNCTAD, 2017

INTRODUCTION

- Seaborne trade constitutes almost 90% of world trade in term of volume and about 80% in term of value.
- It is linked almost in every international supply chain.
- A maritime supply chain is facing a challenge to cope with the vast size of the network that global carriers operate.
- 10.3 billion metric tonnes of goods shipped, 1.9 billion dead-weight tonnes of the world commercial fleet, (UNCTAD, 2017).
- Shipping lines may operate a fleet of more than 500 vessels annually.
- Operating a liner shipping network is truly a big-data problem.
- A maritime industry is rich with amounts of data available to be analysed.

INTRODUCTION

- At ports, managers and authorities need to reach valuable insights from high volume, velocity, variety and value of data using such reliable data analytical approach.
- Optimisation within maritime logistics is complicated due to the uncertainty, complexity and difficult accessibility of data.
- Data applications play an important role in present and future research applications.
- These applications can be divided into two different categories including:
  - ✓ Database Management (DM)
  - ✓ Data Analytics (DA)
- This paper aims to discuss the DA concept in a maritime industry.

RESEARCH PURPOSE AND PROBLEM

- The purpose of this paper is to develop an optimisation model for a maritime seaport using Multi-Dimensional Analytical (MDA).

How can ports be more responsive by leveraging the advantages of the big data analytics?

- This purpose requires the following objectives:
- Exploring the big data concept in the maritime supply chains
- Identifying big data sources and the applications of big data concept in maritime industry
- Developing a maritime big data model
- Integrating of multidimensional data models with analytics over big data

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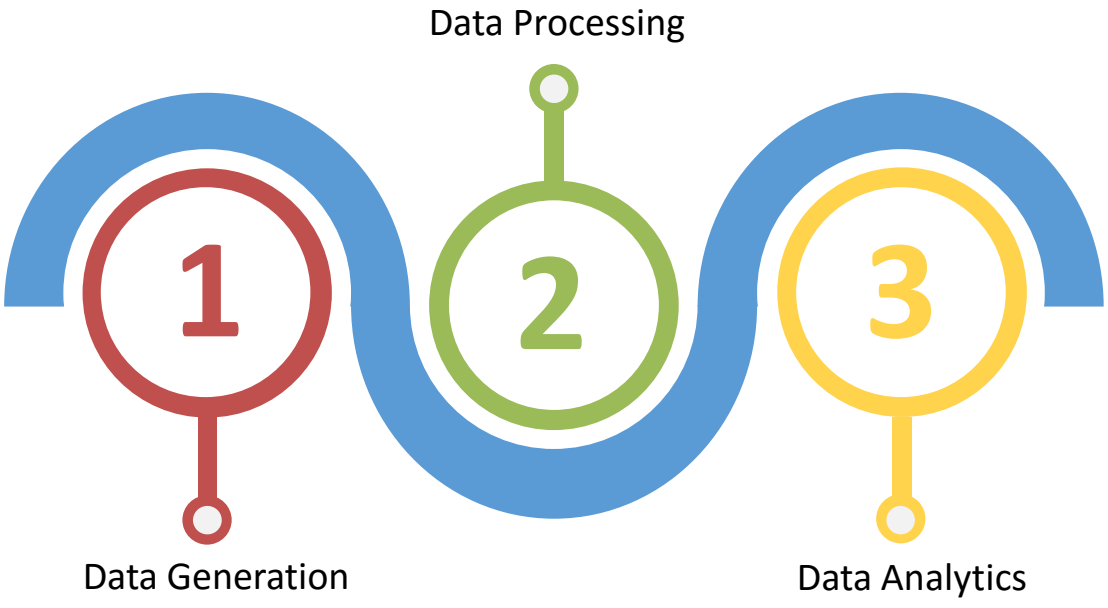
BIG DATA AND SUPPLY CHAIN ANALYTICS

3 steps to follow



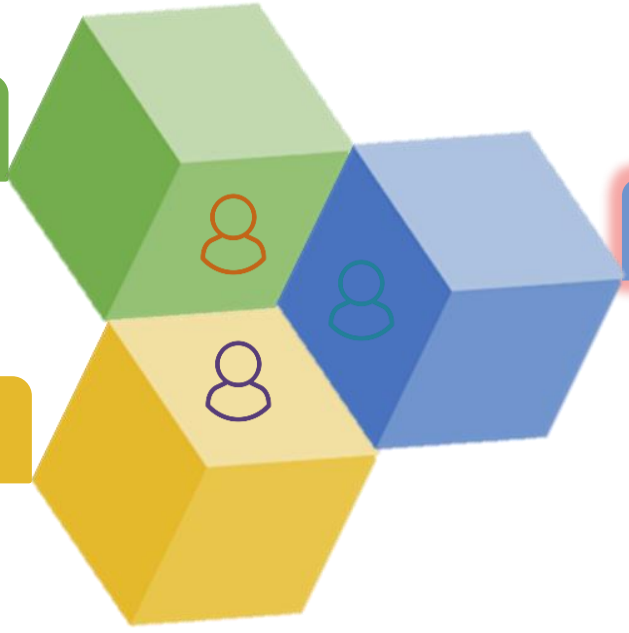
BIG DATA

- Big data is a term that describes the large volume of data – both structured and unstructured – that inundates a business on a day-to-day basis.
- But it's not the amount of data that's important. It's what organizations do with the data that matters.
- Big data can be analyzed for insights that lead to better decisions and strategic business moves

MAIN ATTRIBUTES OF BIG DATA “5VS” CONCEPT

Gandomi and Haider (2015)

Variability
Complexity



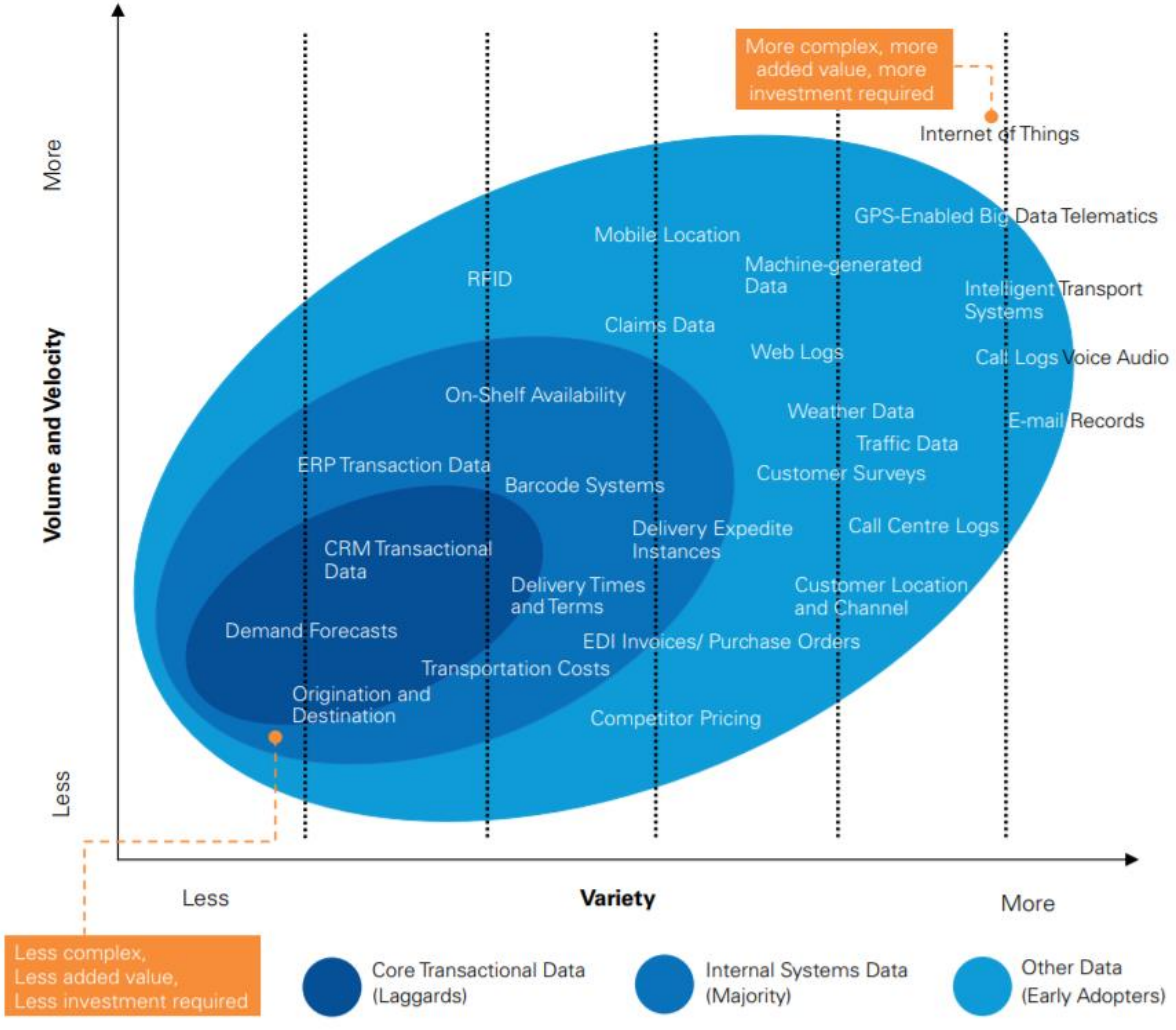
Oussous et al. (2017)

Vision
Verification
Validation
Immutability

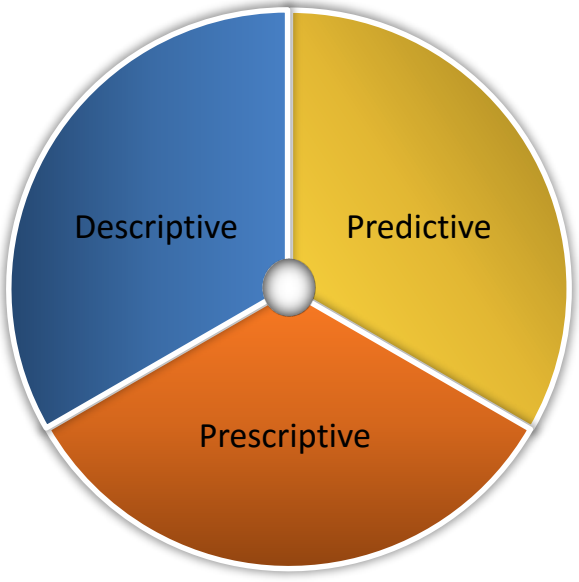
Gunther et al. (2017)
Addo-Tenkorang and Helo (2016)

Volume
Velocity
Variety
Verification / Veracity
Value

SUPPLY CHAIN BIG DATA



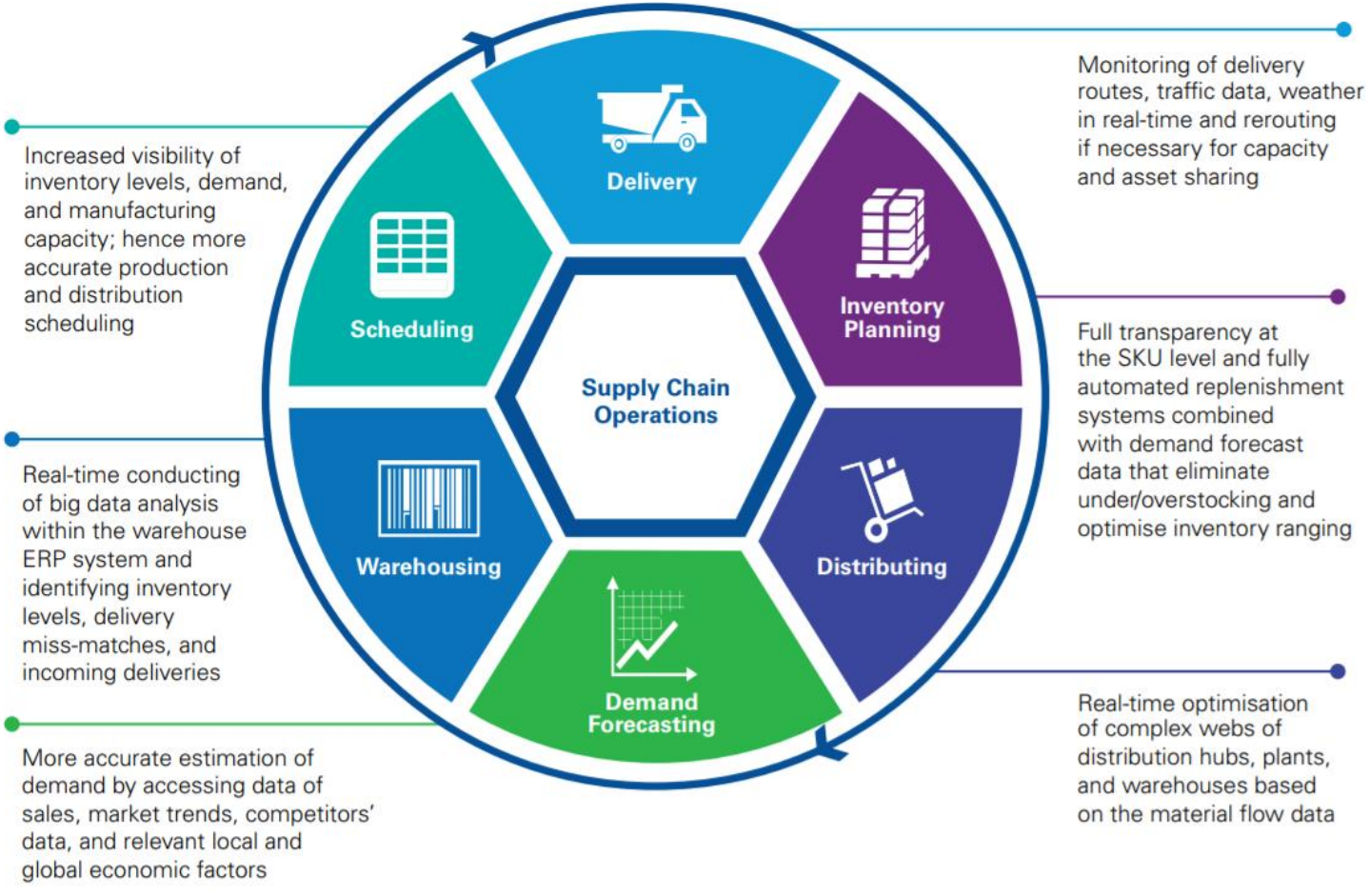
BIG DATA APPLICATIONS IN SCM



Wang et al., 2016

Sivarajah et al. 2017

BIG DATA APPLICATIONS IN SCM

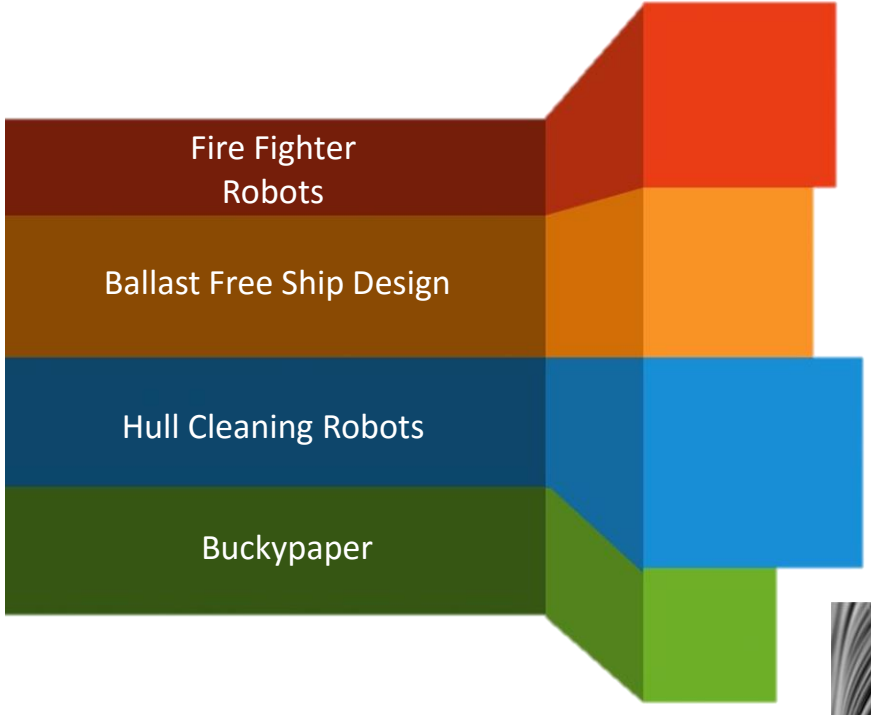


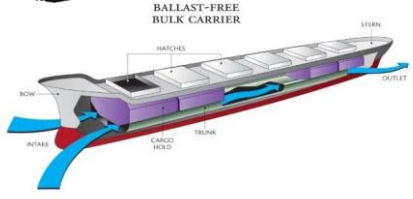
Source: KPMG

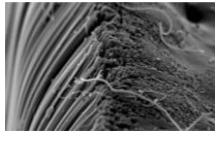
3

BIG DATA APPLICATIONS IN MARITIME TRANSPORT

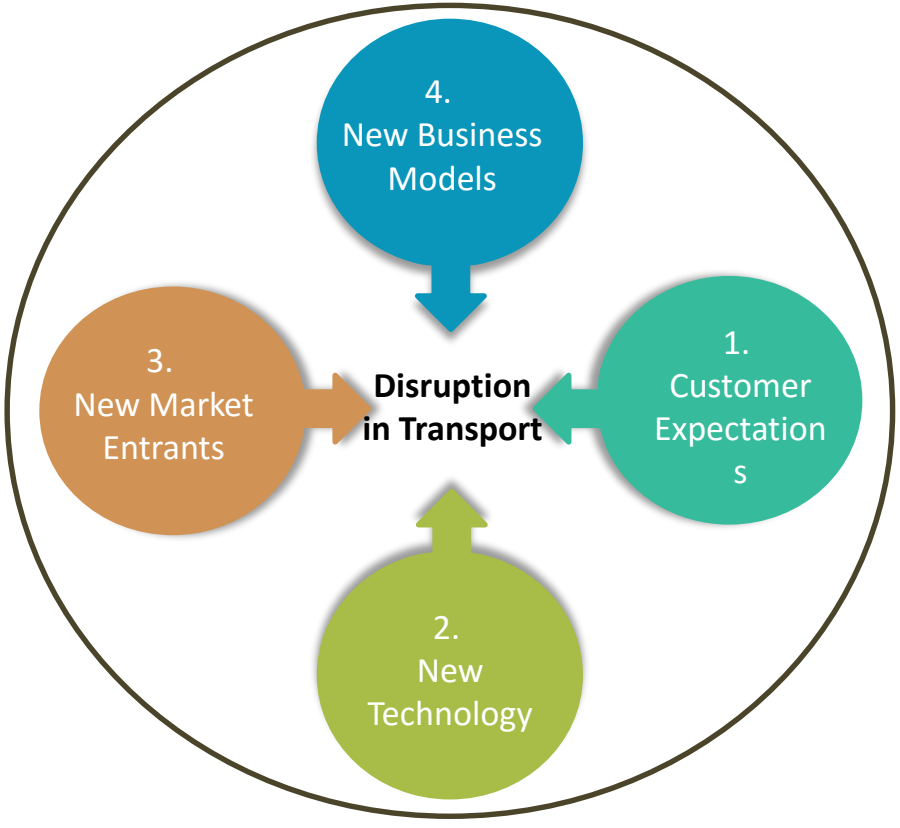
Maritime Innovations

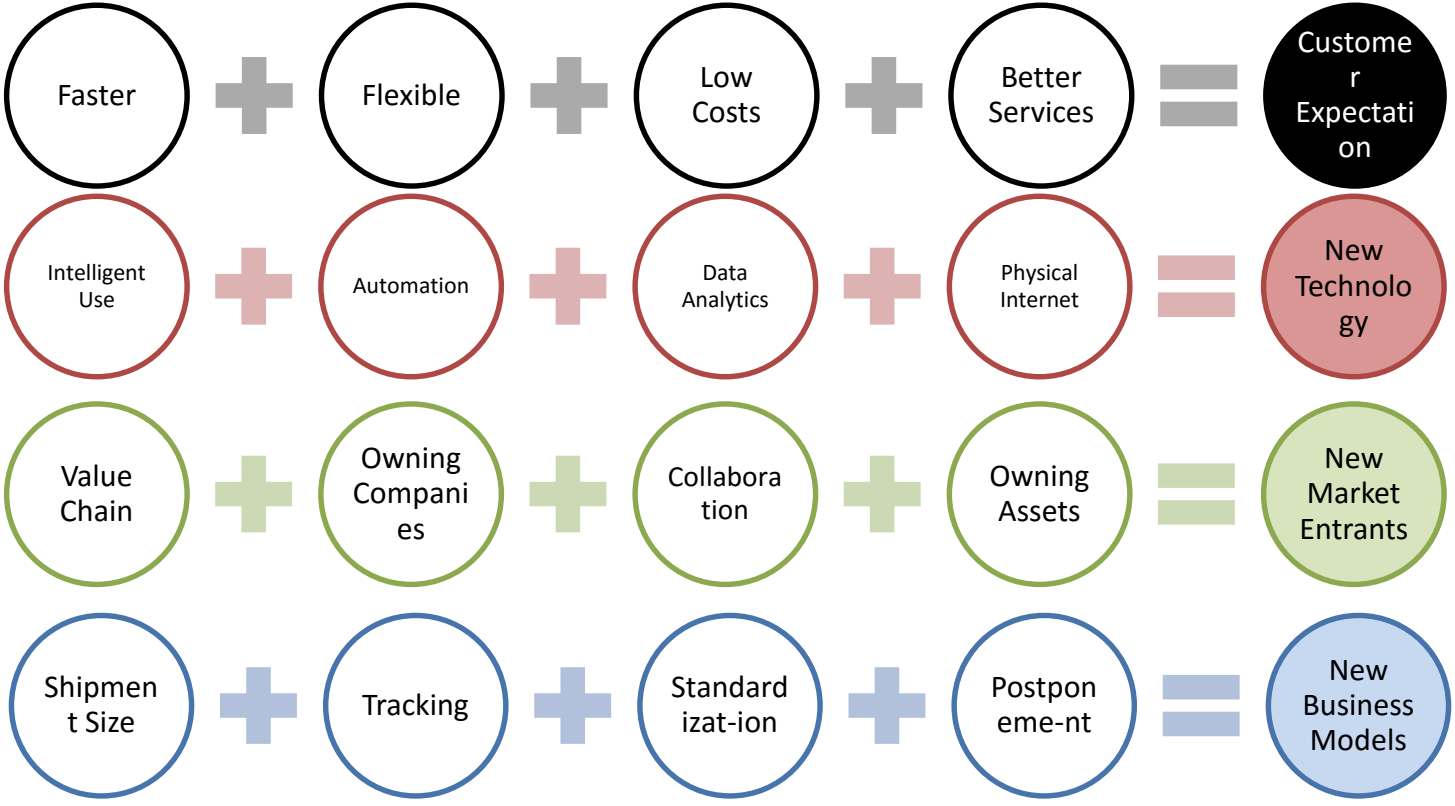






DISRUPTION OF MAIRITIME TRANSPORT INDUSTRY

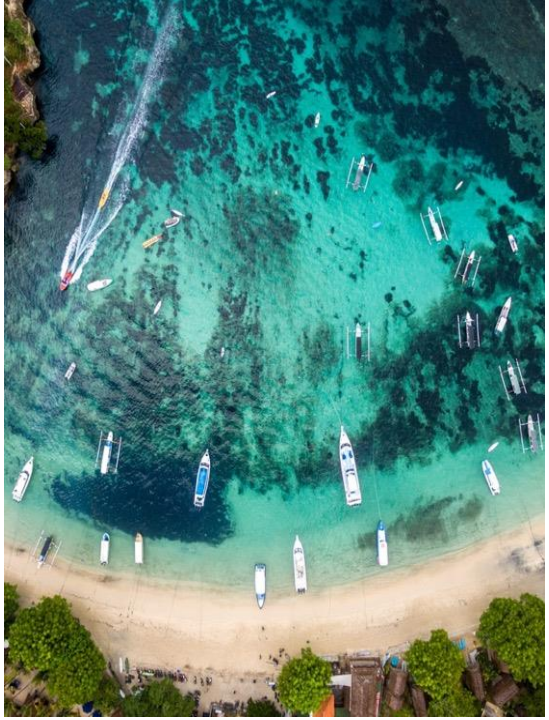



Faster
Flexible
Low Costs
Better Services
Custome r Expectati on
Intelligent Use
Automation
Data Analytics
Physical Internet
New Technolo gy
Value Chain
Owning Compani es
Collabora tion
Owning Assets
New Market Entrants
Shipmen t Size
Tracking
Standard izat-ion
Postpon eme-nt
New Business Models

No#	Technology	Impact	Disruption
1	Physical Internet	Safety and Efficiency	Data privacy Data security regulations
2	IT Standards	Collaboration	Data security
3	Data Analytics	visibility	Data processing capacity
4	Cloud	New platform-based business models	Unclear costs
5	Block chain	Supply chain security Reduction of errors	Uncertain rate of adoption
6	Robotics and automation	Reduction in human workforce	Unclear speed of technology development
7	Autonomous Vehicles	Increased efficiency	Regulatory environment
8	3-d Printing	Lower transportation	Unclear speed, scale and scope

BIG DATA IN MARITIME TRANSPORT

1. Cooperative cognitive maritime big data systems (CCMBDSs) (Yang et al., 2018)
2. Automatic Identification System (AIS) (Asia-Pacific Data Centre, 2018)
3. Automatic maritime route generation algorithm (Zhang et al., 2018)
4. Data sources in the European datAcron project (Vouros et al., 2018)
5. A multidimensional of collected data of administrative barriers to innovative development of the Polish marine industry (Semenov, 2018)



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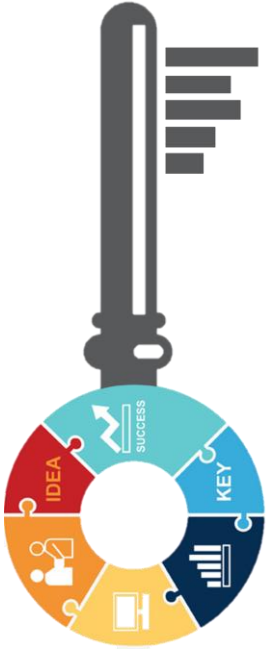
A MARITIME BIG DATA MODEL DEVELOPMENT

THE MODEL



Multi-dimensional Analytical Approach

Data Dimensions

Data of Ports' Operations

Data Measures

Big Data Five Attributes

volume, velocity, variety, verification and value

Ducruet, 2017

Gunther et al. (2017)
Addo-Tenkorang and Helo (2016)

DATA MEASURES - THE 5VS ATTRIBUTES

Big Data Attributes	Measures	Given Symbols
Variety (V_1)	- Technological advances - Type of data	• t_1 • t_2
Velocity (V_2)	- Data generated rate - Real time analytics	• d_1 • r_1
Volume (V_3)	- Time for gathering data - Data management technology	• t_3 • d_2
Veracity (V_4)	- Analysis tools - Valuable information generation - Management of uncertain data	• a_1 • i_1 • m_1
Value (V_5)	- Analysing large volume of data	• a_2

Source: developed by the researcher

DATA DIMENSIONS- Data of Ports' Operations

1. Technological advances
- ability to provide cargo tracing (a3)

2. Type of data
- high frequency of sailing (h1)
- berthing the vessels in ports (b1)
- stowage of containers on vessels (s1)

3. Data generated rate
- prompt response to claim (p1)

4. Real time analytics
- on-time pick-up (o1)
- routing containers through the physical transportation networks (p2)

5. Time for gathering data
- courtesy of inquiry (c1)

6. Data management technology
- ability to provide door-to-door service (s2)
- schedule for individual service in ports (s3)

7. Analysis tools
- good condition of containers (c2)

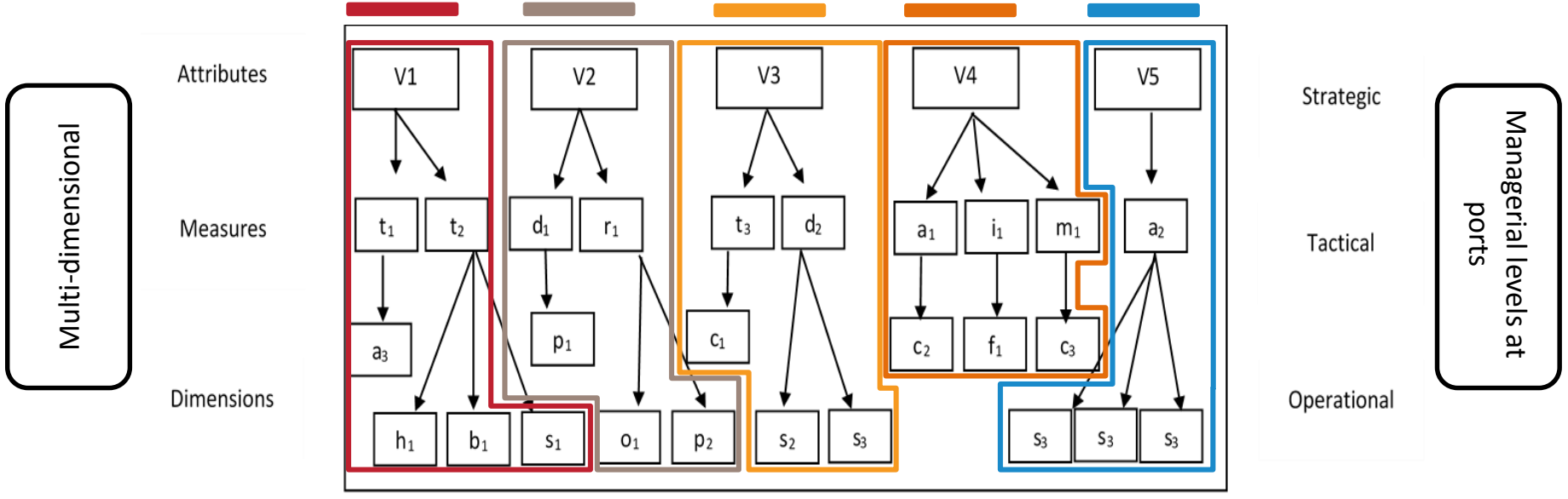
8. Valuable information
- good financial condition (f1)

9. Management of uncertain data
- ability to provide customs clearance service (c3)

10. Analysing large volume of data
- Port related data (p3)
- Vessel related data (v1)
- Goods related data (g1)

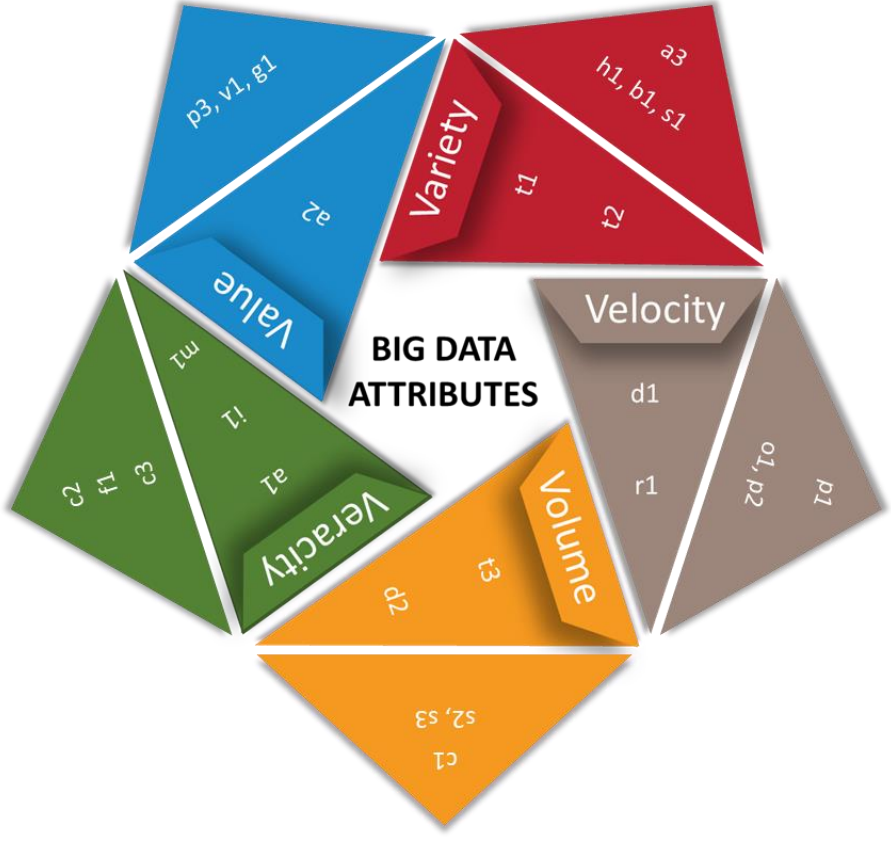
Source: developed by the researcher

Maritime Big Data Analytics Framework



Source: developed by the researcher

Maritime Big Data Analytics Framework

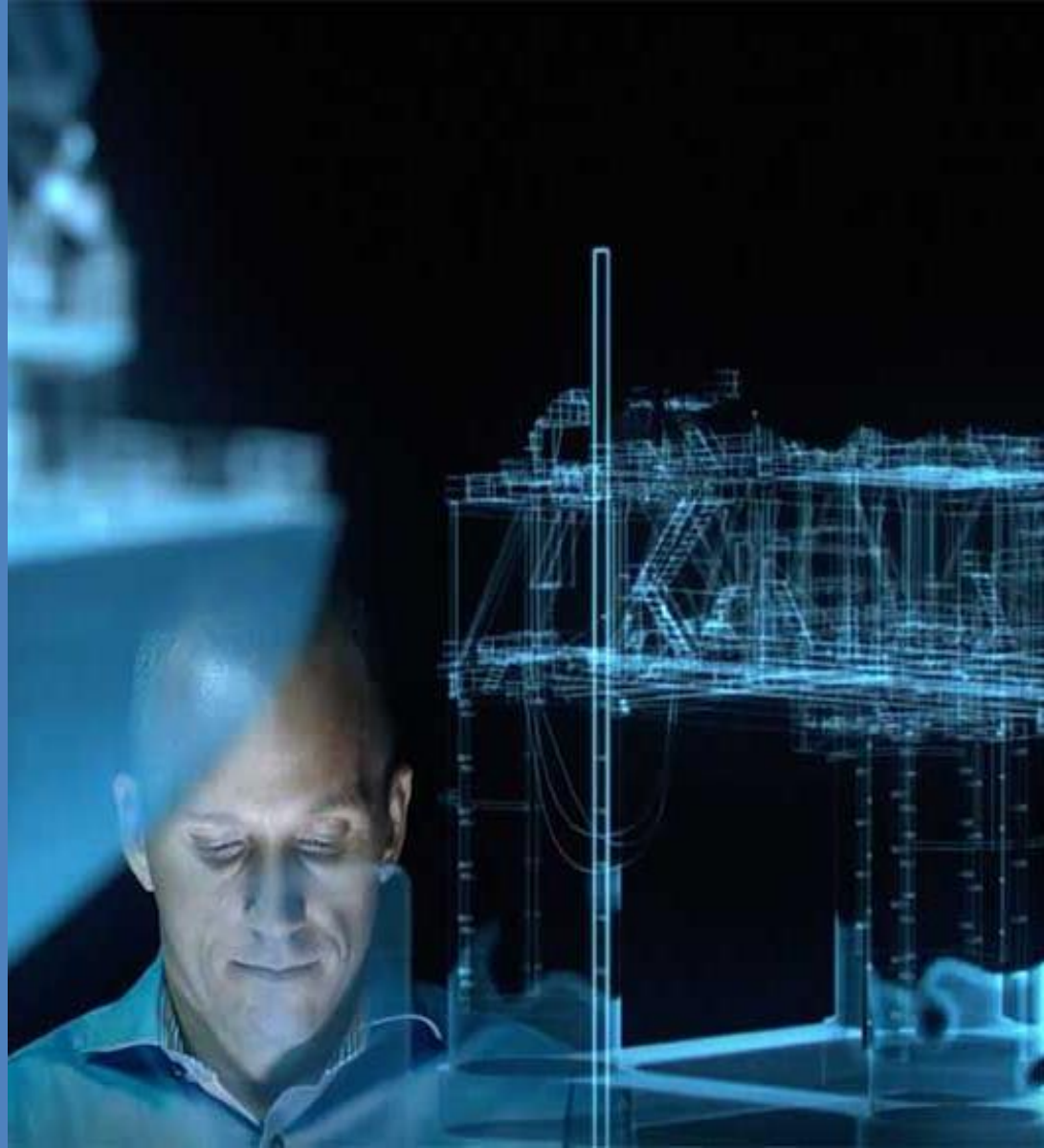


RESEARCH RESULTS

1. Big data dimensions in ports are identified.
2. Measures of big data attributes in ports are identified.
3. Mapping the big data dimensions (operations) with attributes and associated measures in ports.
4. Big data analytics in maritime is still facing many challenges in which can be presented in four groups as follows:
   - Security challenges where data are collected and shared by many entities in ports' community.
   - Technological challenges in term of difficulties of data integration, analytical tools and flexibility.
   - Human resources where there is a lack of specialised persons who handle and analyse data.
   - Data governance where data are highly secured.

5

MULTIDIMENSIONAL DATA AND ANALYTICS



MULTIDIMENSIONAL DATA AND ANALYTICS

- The developed maritime big data model needs to be adopted using big multidimensional data approach.
- Multidimensional data represent an add-on value for analytics models and methodologies.
- Different multidimensional data models can integrate with analytics including (Cuzzocrea et al., 2011) :
  - ✓ Multidimensional abstractions
  - ✓ Hierarchy-based dimensional tables
  - ✓ Multi-resolution fact tables
  - ✓ Multi-way aggregations

How to achieve an effective integration of multidimensional data models with analytics over big data?

- Improve the query efficiency on cloud storage by the optimal utilisation of storage resource and data migration.
- Things like data sensitivity, data access frequency, data time length, and data size should be fully considered when performing data migration. The migration function can be presented as follows:

$$D(V_1, V_2 \ldots, V_n) = \sum_{i=1}^{n} \frac{1}{Ti} \times \sum_{K=1}^{n} fk \times \frac{1}{S}$$

MULTIDIMENSIONAL DATA AND ANALYTICS

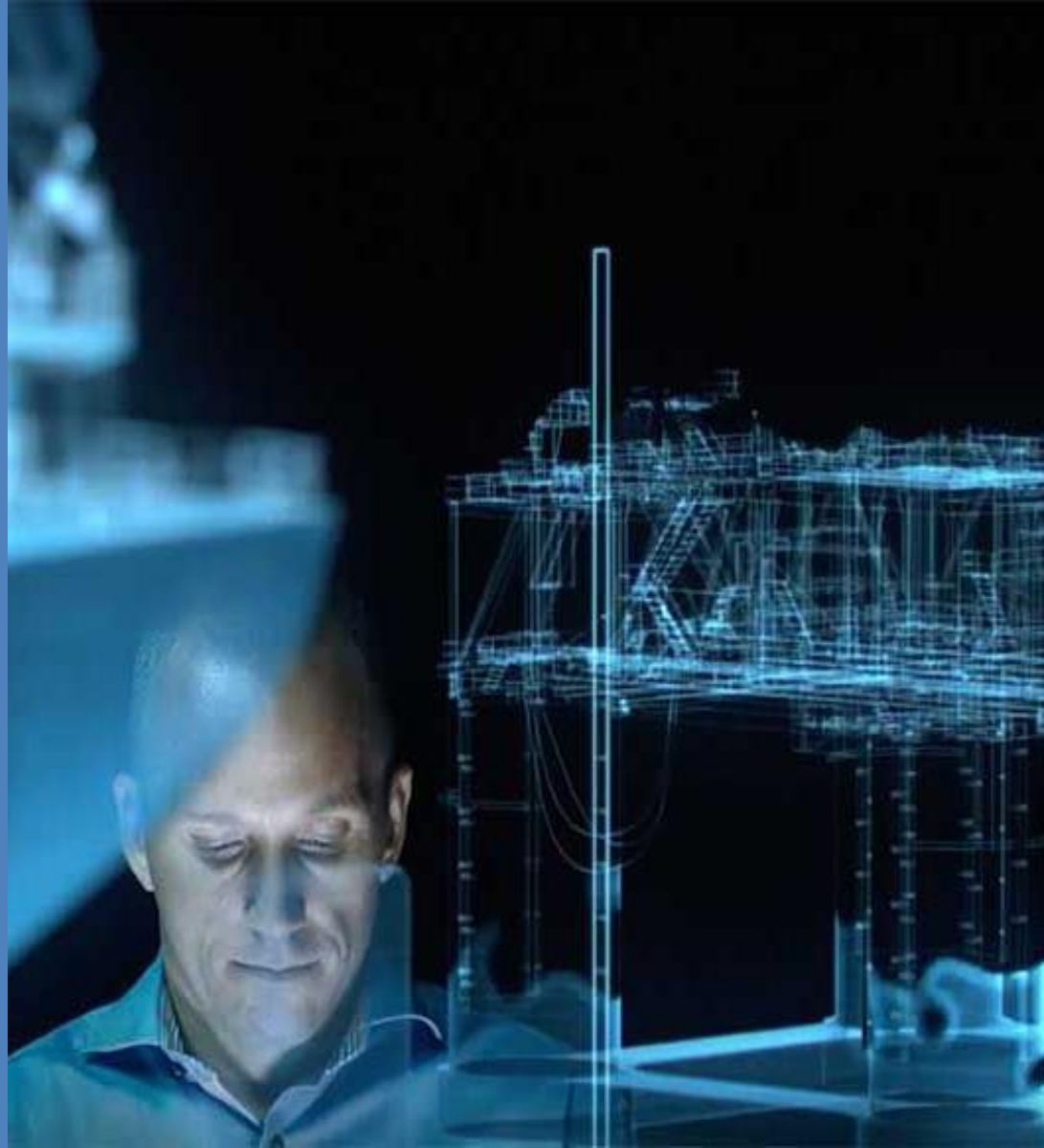
- Operations at ports are characterised by complexity and high uncertainty.
- Turning maritime big data into maritime big value.
- Information entropy can be applied for this purpose
- It is a logarithmic measure of the rate of transfer of information in a particular message or language.
- Entropy refers to disorder or uncertainty associated with each possible data value.
- The entropy function is shown as follows:

$$H(X) = E(I(X))$$

- According to the huge data collected from different sources in a maritime supply chain, the maximum rate at which information can be transmitted over a communication channel can be formulated as follows:

$$C(V1, V2 \ldots\ldots Vn) = B \log_2 (1+S/N)$$

6
CONCLUSION



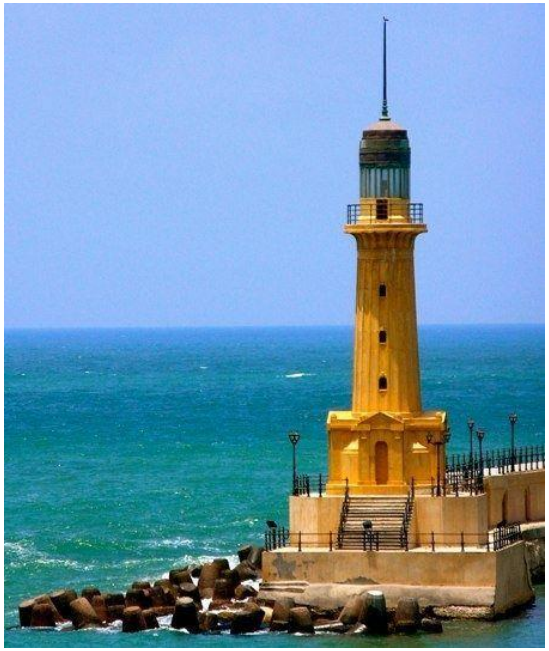
CONCLUSION

1. New concepts and technologies received a wide attention such as big data and data mining.
2. There are many tools of big data such as storage and management, data cleaning, datamining and data analysis.
3. There are various trends of big data including displacement to the cloud, integration with Internet of Things (IoT), and security improvement.
4. Existing challenges in different fields and industries are presented in term of data analysis.
5. Big data is not a single technology, technique or initiative rather it is a trend across many areas of businesses.
6. In a maritime supply chain, there is no doubt that study on maritime big data management is still in the initial stage of development.
7. The developed model aims to discover accessible maritime big data, its measures and dimensions, and the possible values that could be obtained from it.
8. It helps to improve ports' strategic, tactical and operational planning.
9. A migration function can be used by ports' authorities and managers to assure the optimal utilisation of data storage resources.

FURTHER RESEARCH

- Currently applying the big data model on two ports:
  - Alexandria port
  - Damietta port

- Future challenges include:
  1. Data dynamic scalability
  2. Controllable maritime data size
  3. Maritime database consistency
  4. Maritime database usability
  5. Maritime data analysis algorithms
  6. Quality of maritime big data



THANK YOU

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