Integration of Circular Economy principles in the Smartship project

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Circular Economy Research Center - CERC

COMMITTED TO CUTTING EDGE RESEARCH

- At **École des Ponts Business School,** we excel in education and research, with a special focus on circular economy and sustainability.
- Our **Circular Economy Research Center** spearheads business model innovation, blending digitalization with sustainable strategies.
- We're adept in skill development, and our approach to business model innovation sets us apart.
- As a partner in EU funding proposals, we offer expertise in disseminating cutting-edge knowledge, ideal for consortiums dedicated to pioneering a sustainable and innovative future.

Increased need for sustainability in the maritime industry

- With an ever-mounting climate challenge and with the whole world as one global integrated market, being in **control of energy consumption** and CO2 emissions is a **crucial area for future-proofing operations**
- Need to **reduce direct and indirect emissions** from the shipping sector
- Need for sustainable ship recycling and for **ensuring the re-introduction of materials** into the cycle to be used to manufacture new products
- Need to prop

Maritime industry challenges

Fuel consumption and greenhouse gas emissions

The containership industry faces the challenge of reducing fuel consumption and mitigating GHG emissions due to volatile fuel prices and environmental concerns.

Safety of life at sea

Voyage planning and execution must prioritize the safety of crew members, ensuring their well-being during the entire journey.

Safety and efficiency of navigation

The containership industry needs to optimize navigation practices to enhance safety and efficiency, reducing the risk of accidents and delays.

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Maritime industry challenges (Cont.)

Protection of the marine environment

Voyage planning and execution should also consider minimizing the environmental impact, protecting the marine ecosystem and preserving biodiversity.

Maintenance of physical assets

Maintaining the useful life of vessels' physical assets is crucial. Traditional maintenance techniques, such as run-to-failure or periodic preventive maintenance, may be costly and ineffective, necessitating more efficient approaches.

Accurate and reliable real-time information

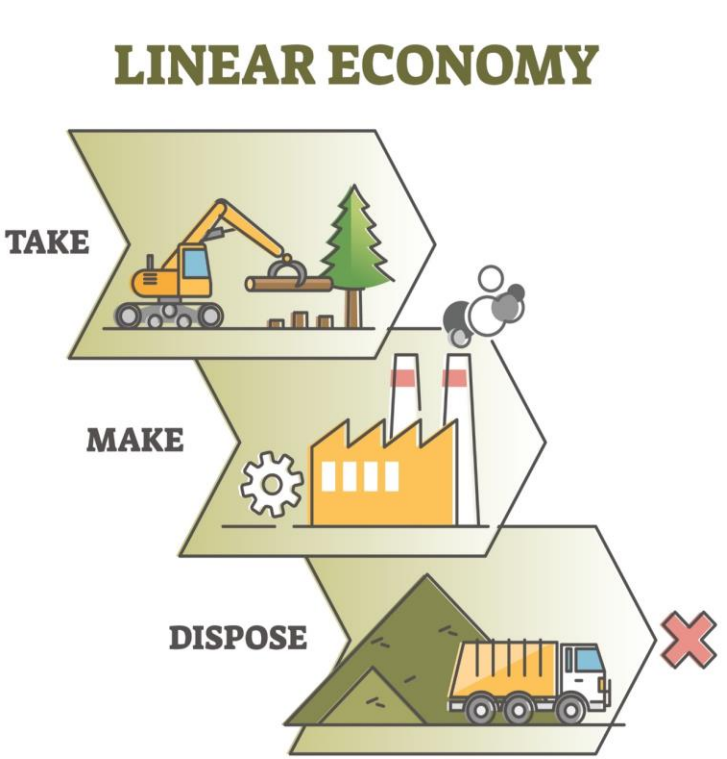
Cargo shipping companies require up-to-date information on fleet navigational performance, fuel oil consumption, and other relevant data to make informed decisions and optimize operations.

Integration of intelligent IT systems and sustainability

Forward-thinking maritime companies recognize the importance of adopting intelligent IT systems, such as Ship Performance Monitoring systems, to enhance competitiveness. Additionally, sustainability factors have become a significant consideration for containership customers, and addressing sustainability is essential for the industry's long-term viability.

From linear to circular: the maritime industry

- Linear economic model:
  - raw materials are produced to be used and to become waste
- Circular economic model:
  - production and consumption involves sharing, leasing, reusing, repairing, refurnishing and recycling existing materials and products as long as possible



WHAT IS THE CIRCULAR ECONOMY?

Exact Science

Theoretical Framework

Business Model

A BUSINESS MODEL WITH...

SmartShip: objectives

- Energy efficiency and fuel consumption management
- Environmental compliance with maritime sector regulations in terms of emissions' control
- Exploitation of technologies used for (i) and (ii), considering applications of circular economy (CE) principles in the maritime sector

Circular Economy principles

Keep products and materials in use, maintaining its value and resources value for as long as possible.

Regenerate natural systems by minimizing generation of waste and resource intensity of manufacturing (minimise negative externalities) and fostering system effectiveness.

Design out of waste and pollution to return value of products materials and resources into the product cycle at the end of their use.

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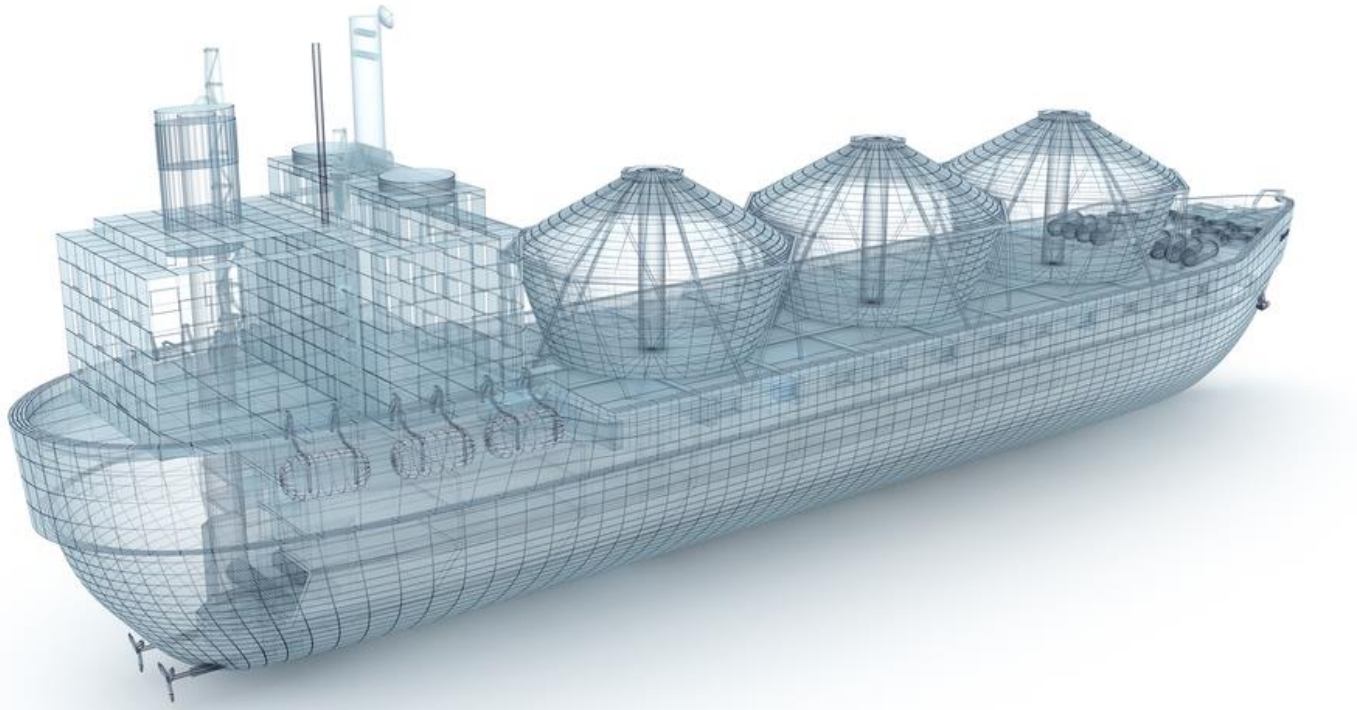


Enabling Circular Economy in the Maritime sector with New Technologies

Digitalization enabling the circular economy

- Increased connectivity
- Gathering, sharing and analysis of data
- Maximizing its value to produce better products and services
- Using of data and digitally enabled solutions to change people’s and businesses’ mindset processes, products and services

IoT in the maritime sector

- **About 47% of maritime businesses use IoT to measure fuel consumption** (electronic reporting), and is expected to increase 100% by 2023

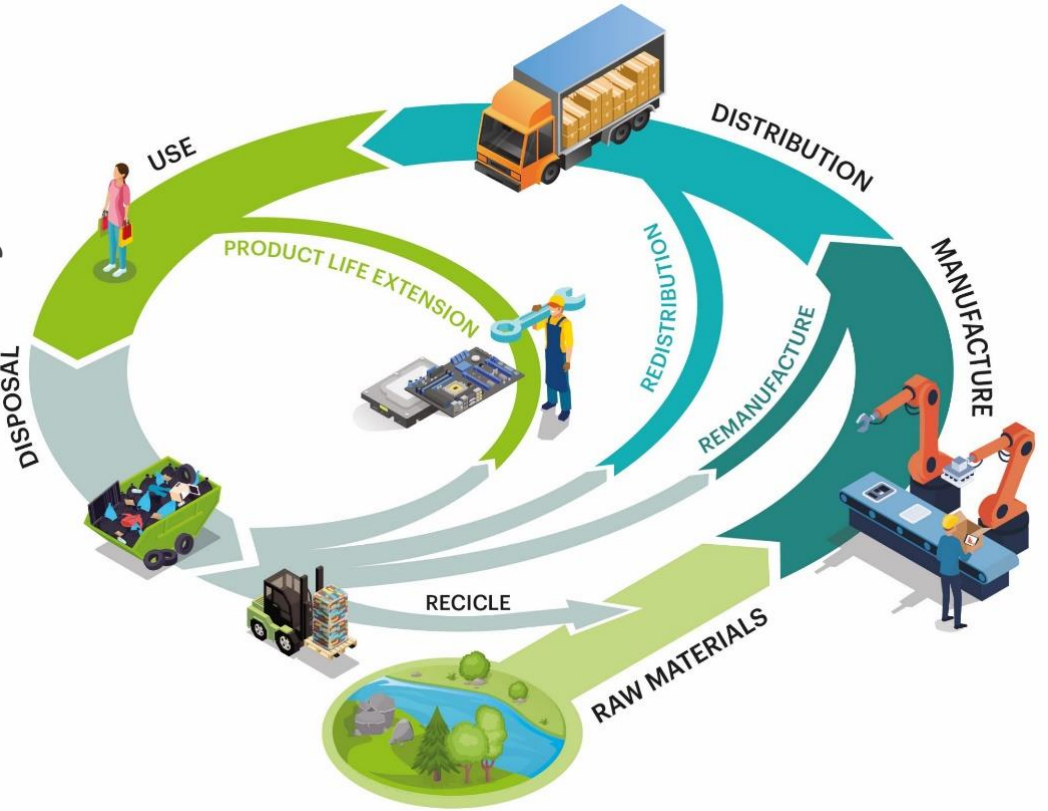
- Increased IoT uptake could improve the **monitoring of ship components** and improve longevity and performance (MarketLine, 2018).
- **Real-time monitoring** could also improve the **scheduling of maintenance** when necessary (MarketLine, 2018)

- 5G could potentially **optimize the routing** undertaken by maritime vessels, resulting in less distance travelled and lowered emissions
- One example of IoT integration is in the Port of Rotterdam which uses IoT sensors (e.g., environmental data) to reduce berthing times by one hour (saving of around 80 K€) (CFTC, 2019)

- **IoT enabled augmented reality glasses** are increasingly being used by ship crew to communicate with support departments remotely.
- Advantages may **include faster resolution of technical faults**, and reduced reliance on having a **technician travel** to the site (reduced emissions or pollutants). Also, may be applied **for medical emergencies to prove safety** (One Net, 2019a)

Circular Economy in the Maritime Sector

- The **CE is increasingly being recognized as a guiding principle for business model innovation.**
- The **pairing of CE and Smart ICT-enhanced maritime fleet management** provides a fertile ground for innovation and **value creation**, paving the way to **explore novel ways** this interaction can change the nature of **products, services, business models, and ecosystems.**
- Still, the **potential** role and opportunity space in the containership industry has **hardly been analysed**.
- **CE principles are not well established**, and the concept is not yet well understood by all stakeholders (Okumus et al., 2023).



SmartShip: ICT & IoT

DATA ANALYTICS

IOT

DECISION SUPPORT SYSTEMS

VISUALIZATION TOOLS

OPTIMIZATION ALGORITHMS

Circular Economy Platform Requirements

Circular Attributes

- **L**ocation
- **C**ondition
- **A**vailability

→

- Allow the monitoring of devices and recommended maintenance actions
- Competitive advantage to improve new products applying circular by design concepts

Circular Design

- **M**odularity
- **S**calability
- **F**unctionality

→

- Based on open standards
- Provides Interoperability with existing IoT environments
- Support the evolution of the platform for relevant changes in the future

Requirement's data collectors

- **E**nd-to-end security / privacy
- **D**ependability
- **O**perability

→

- Anonymization, encryption and authenticity
- Ensure sensitive information

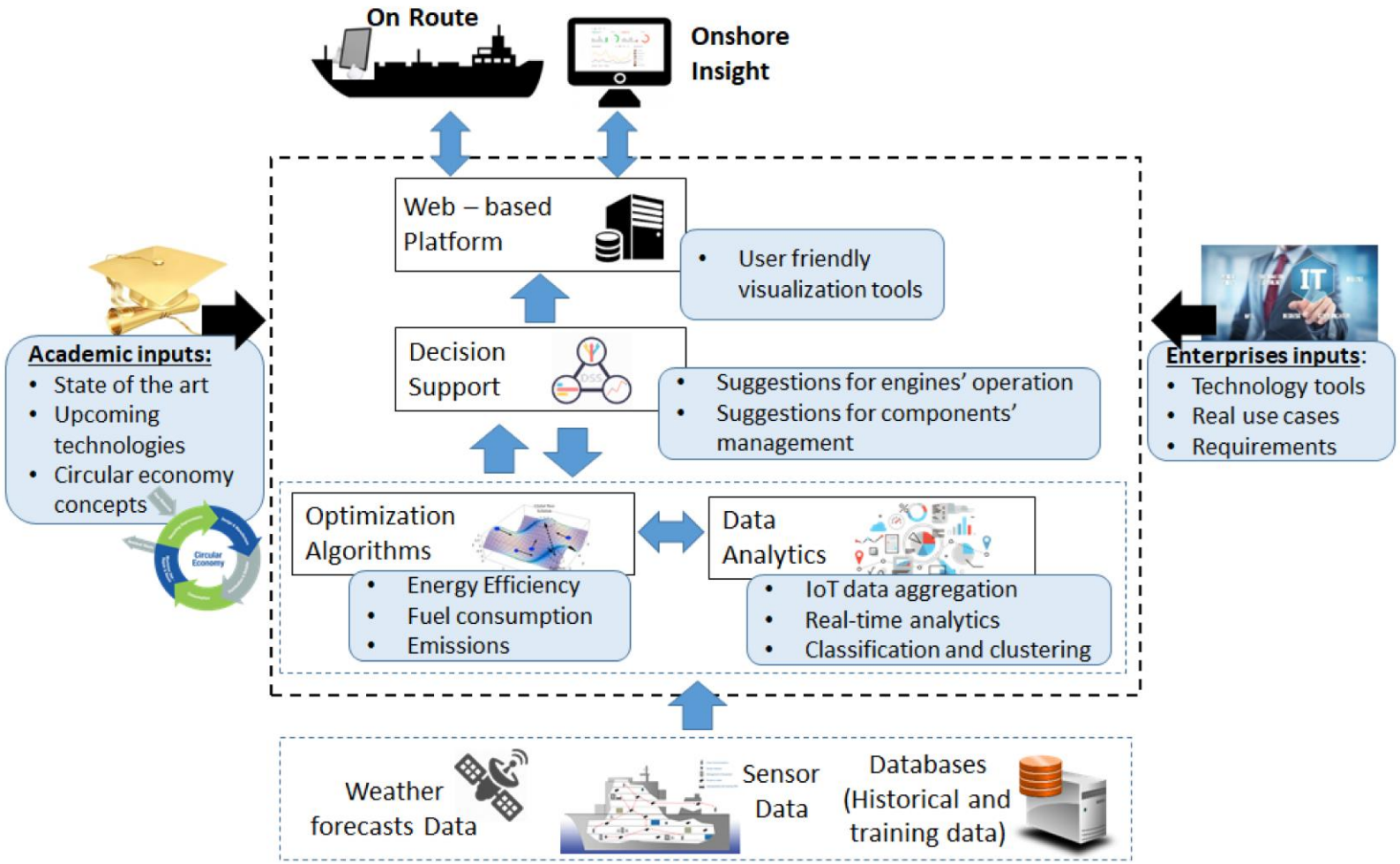
Trust

- **T**rustworthiness
- **C**onfidentiality
- **S**ecurity

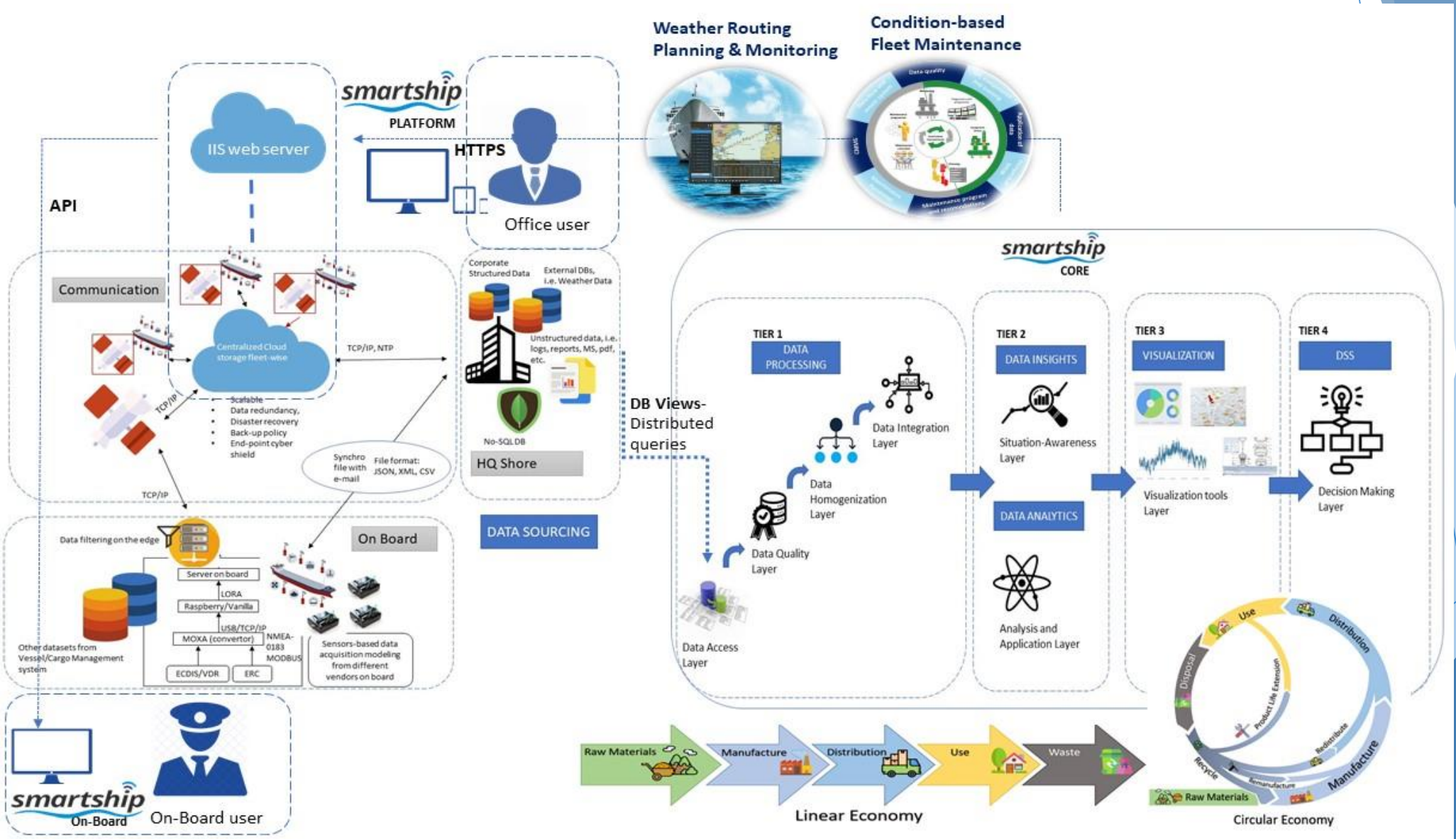
→

- Enable secure trustworthy information exchange by design

1st version architecture



Integrated Architecture design



Opportunities for the circular economy in SmartShip: use cases

- The shipping sector has a large potential for pairing circular economy and Smart ICT
- Opportunities identified in SmartShip use cases:
- **Use case #1 & #2: Weather routing optimization and monitoring**
  - optimized vessel routing
  - Fuel and energy consumption can fluctuate greatly, even between comparable trips, improved monitoring of fuel consumption
- **Use case #3: Condition-based (predictive) maintenance (CBM)**
  - predictive maintenance
  - facilitate remote support (resolve technical failures, assist medical emergencies)

Initial definition of Circular Economy KPIs Use case #1 and #2

Topic	KPI	Applied Use Case	Measurement Validation
Enhance environmental performance in Shipping operation	Assessment of Results in Voyage performance in terms of fuel consumption and emission control compliance due to SmartShip routing advice	#1,#2	At least 5% enhancement in environmental performance due to SmartShip routing scenarios against existing algorithmic-based routing advices
Value added proposition to existing tools	Improvements in Performance % of existing weather routing optimization tool	#1,#2	At least 5% improvement in accuracy of routing advice and voyage performance evaluation due to SmartShip build-in functionalities
Through Circular Economy principles enhance the uptake of new fuel technologies.	Performance of a feasibility study.	#1, #2	Identification of at least two new fuel technologies from the ones currently used in the sector.
Through Circular Economy monitoring or energy-efficient operations performance	Monitoring Energy efficient operations performance	#2	Identify at least a 10% improvement on the Fuel Operational Consumption (FOC) model
Enhance the uptake of Circular Economy in the maritime sector	Performance of a Gap analysis	#1,#2,#3	The identification at least two improvements from the current business models used.
Knowledge transferability between academic and non-academic experts	Whitepapers & publications in professional journals	ALL	At least 2 techical papers or 4 papers in international conferences or journals introducing achievements and new approaches as applied in SmartShip use cases

Initial definition of Circular Economy KPIs
Use case #3 and #4

Topic	KPI	Applied Use Case	Measurement Validation
Value added proposition to existing tools	Improvement in results of existing vessel performance monitoring tool	#3	At least 5% enhancement in anomaly detection and failure prediction of vessel machinery components due to SmartShip build-in functionalities
Circular Economy Concept	Introduction of Circular Economy criteria in maritime operation	#3	At least 5% improvement in Engine fatigue treatment and performance monitoring to prolong asset lifetime and retain value.
Circular economy	Reuse and remanufacturing strategies and operations	#3	Development of at least 1 reuse and remanufacturing Database of materials for engine components
Circular Economy	Collaboration to foster an extended lifetime of products	#3	At least 1 contact with stakeholders on the product life supply chain
Value added proposition to existing tools	Improvement in user friendliness and experience	#4	User acceptance validation test by DANAOS staff
Enhance the uptake of Circular Economy in the maritime sector	Performance of a Gap analysis	#1,#2,#3	The identification at least two improvements from the current business models used.
Knowledge transferability between academic and non-academic experts	Whitepapers & publications in professional journals	ALL	At least 2 technical papers or 4 papers in international conferences or journals introducing achievements and new approaches as applied in SmartShip use cases

Next Steps: Defining Circular Business Models in Smartship

Topic	KPI	Applied Use Case	Measurement Validation
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Defining Circular Business Models in Smartship

CIRCULAR ECONOMY ALLIANCE

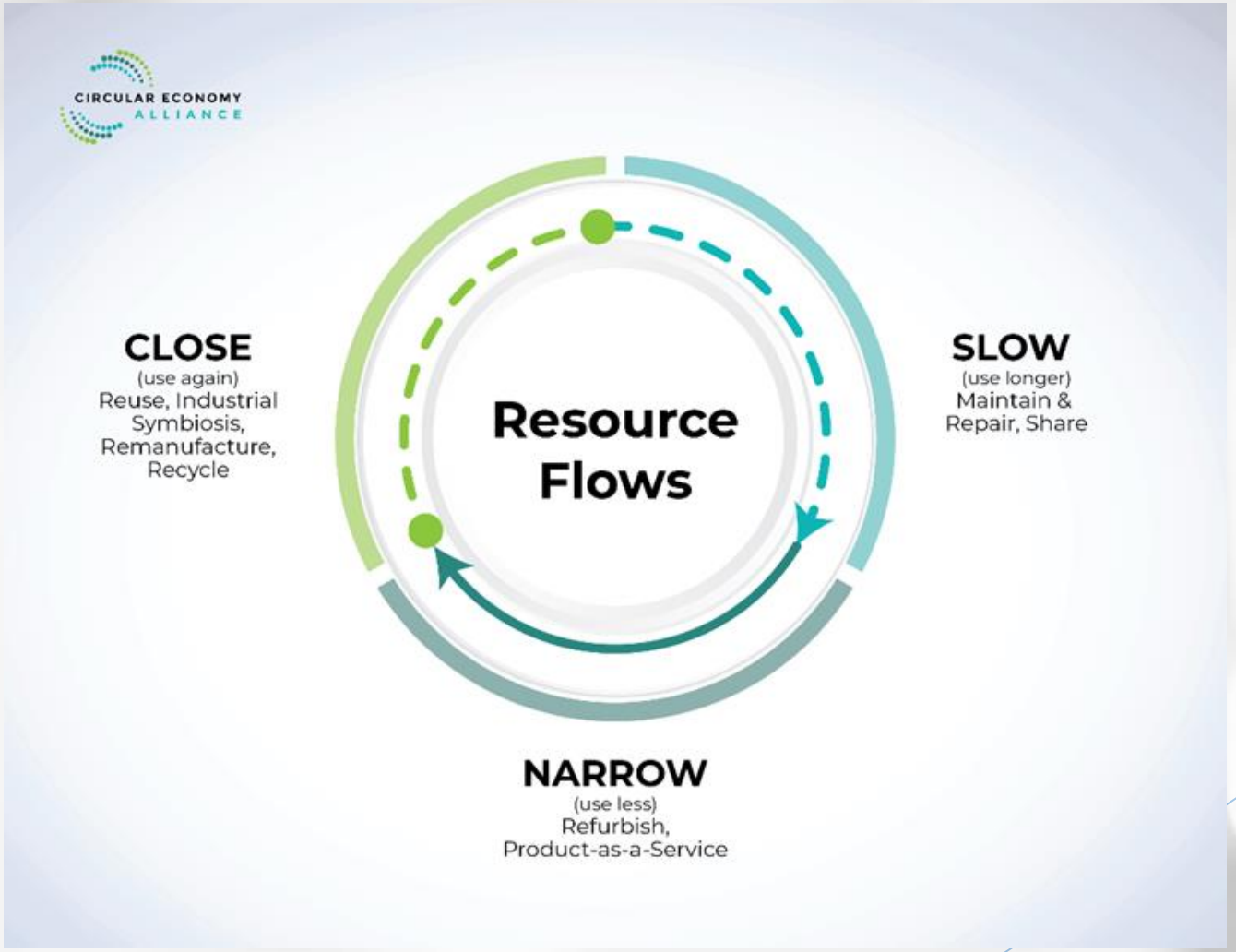
CIRCULAR ECONOMY BUSINESS MODELS
Doing More with Less for Longer

MAPPING CBMS BASED ON RESOURCE FLOWS RESOURCE FLOWS

Slowing Resource Flows

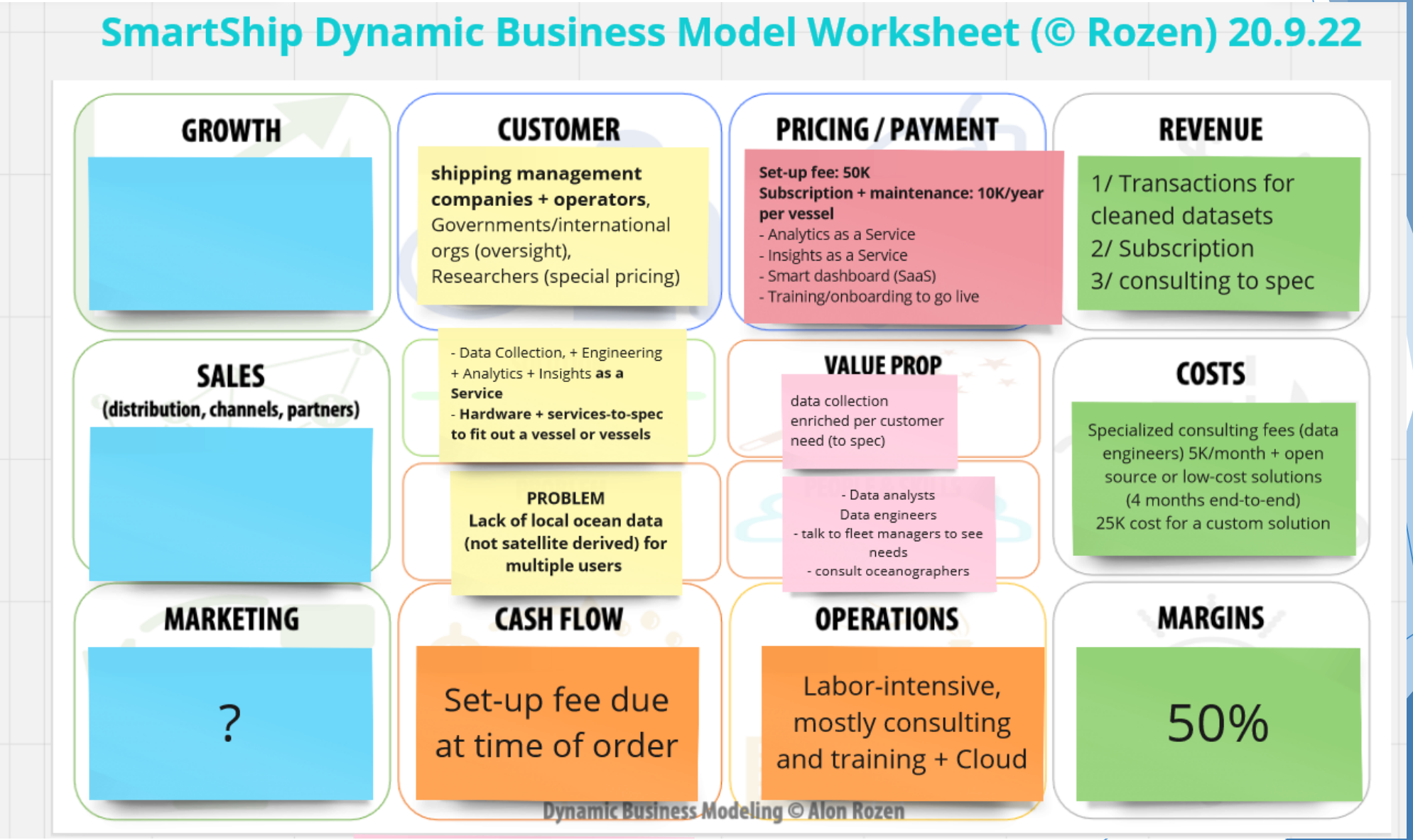
Narrowing Resource Flows

Closing Resource Flows



MAPPING CIRCULAR DESIGN STRATEGIES

Exploitation workshop: Circular Business Model approach



Next steps

The **impact of new technologies on incorporating circular economy principles** and creating value for shipping companies, the **attributes enabling circular business models for sustainable vessel management**, and the **improvement of existing vessel monitoring tools through circular strategies.**

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THANK YOU

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