The SmartShip project has received funding from the European Union's Horizon 2020 research and Innovation programme under the Marie Skłodowska-Curie grant agreement No 823916

Project Acronym:	**SmartShip**
Project Full Title:	**A data analytics, decision support and circular economy – based multi-layer optimization platform towards a holistic energy efficiency, fuel consumption and emissions management of vessels**
Project Duration:	**60 months (01/04/2019 – 31/03/2024)**

Deliverable 1.3:
Third Year Project Report

Work Package	**WP1 – Project management and secondments coordination**
Task	**T1.1 – Administrative project management**
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Executive Summary

This deliverable is in line with Article 19.1 of the Grant Agreement 823916 and provides the third year progress report of the SmartShip project funded by the Horizon 2020-MSCA-RISE-2018 Action.

The principal aim of SmartShip is to foster knowledge exchange between experts of complementary technology fields (IoT, Data Analytics, Visualization Tools, Optimization Algorithms) applied in the frameworks of Energy Efficiency & Emissions management, towards a holistic framework for energy efficiency and emissions control, thus materializing the next-generation paradigm for the maritime industry. In this context, by capitalizing on available COTS technologies and limited RTD, SmartShip 's overall objective is to deliver an ICT & IoT-enabled holistic cloud-based maritime performance & monitoring system, for the entire lifecycle of a ship, aimed to optimize energy efficiency, emissions reduction, fuel consumption, and at the same time include circular economy concepts in the maritime field.

The deliverable updates status and progress of work performed from M12 in continuation of documented report in D1.1, which covered progress of the first year of the project (M1-M12). This deliverable also constitutes a consolidated record of all partners' effort for the successful delivery of project objectives up to the third year of the project (M36). It is beyond any doubt that progress so far is highlighting the high spirit of collaboration between partners as expressed by the solid synergies achieved for effective and safe execution of project tasks. Some minor issues that have been identified during this period are duly documented and disclosed. Appropriate mitigation measures connected to already identified risks have been revised or materialized as well as new risks which have been registered and analyzed.

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List of Acronyms and Abbreviations

Term	Description
ADM	Administrative
AI	Artificial Intelligence
AIS	Automatic Identification System
API	Application Programming Interface
CE	Circular Economy
CERC	Circular Economy Research Center
DB	DataBase
DHCP	Dynamic Host Configuration Protocol
DoA	Description of Action
EC	European Commission
ESR	Early Stage Researcher
ER	Experienced Researcher
EU	European Union
GPS	Global Positioning System
GPU	Graphics processing unit
GRE	Generic Routing Encapsulation
HW	HardWare
ICT	Information and Communication Technology

IoT	Internet of Things
IPSEC	Internet Protocol Security
KPI	Key Performance Indicator
L2TP	Layer Two Tunneling Protocol
LCA	Life Cycle Analysis
M2M	Machine two Machine
MBA	Master of Business Administration
MSCA	Marie Skłodowska-Curie Actions
O&M	Operation and Maintenance
PO	Project Officer
R&I	Research and Innovation
REA	European Research Executive Agency
SW	SoftWare
TCP/IP	Transmission Control Protocol/Internet Protocol
WP	Work Package

Partners Short Name	
DANAOS	DANAOS SHIPPING COMPANY LIMITED
ITML	INFORMATION TECHNOLOGY FOR MARKET LEADERSHIP
EPS	EPSILON MALTA LIMITED
ENPC	ECOLE NATIONALE DES PONTS ET CHAUSSEES
BLS	BLUESOFT SPOLKA Z OGRANICZONA ODPOWIEDZIALNOSCIA
TUBS	TECHNISCHE UNIVERSITAET BRAUNSCHWEIG
HUA	HAROKOPIO UNIVERSITY

1. Introduction

1.1 Scope and objectives of the deliverable

SmartShip has reached the third year of scheduled project work-plan. This deliverable records results achieved regarding the technical implementation of the project and the secondment implementation. Moreover, it sums up actions in project management and reporting progress on training, exploitation and communication plan.

Scope of this report is to highlight:

- Progress and results of each project segmented work-section for period between M12 and M36 (Work packages);
- Any recorded deviation and issue per work package for the period in reference along with short-term next actions;
- A consolidated overview of project earned value, deliverable(s) completed, and achievements up to M36;
- Implementation of secondments including a report on recorded deviations against the initial plan up to M36;
- Report on knowledge transfer and research activities as product of secondments' realization up to M36;
- A continuous identification and monitoring of risk factors;
- Activities for promoting and communicating project results;
- Updates in exploitation and training plan.

1.2 Structure of the deliverable

The deliverable consists of five main sections:

First section includes the reporting of progress as witnessed in each work package including any noted deviations and follow-up steps. **Second section** presents a full report of the completed and ongoing secondments along with the results and research achievements as stemming from the interactions between stakeholders of the project. In the **third section**, an overall picture of deliverables submitted, and a high-level overview of the technical progress achieved until M36 is portrayed.

Risk analysis is performed in the **fourth section** through revising and updating the provision of required remedy. In the **last section (fifth),** SMARTSHIP's dissemination, exploitation and training strategic plan and related activities are explicitly presented. The document concludes with updates on ethical issues

1.3 Relation to Other Tasks and Deliverables

This document is a sum up of results and progress across the 3rd year of project implementation. By definition, it is taking feedback from work performed in active WPs (WP:1,2,3,4,5,7) and related tasks (T1.1, T1.2, T1.3, T2.1, T2.2, T2.3, T3.1, T3.2, T3.3,T4.1, T4.2, T4.3, T5.1, T5.2,T5.3, T7.1, T7.2, T7.3) for the period in reference (3rd year) and delivers a consolidated report for results achieved. The deliverable is projecting the work to be done by referring to the next in-schedule actions associated with each work package tasks.

2. SmartShip Progress and Reporting

2.1 Progress per WP

2.1.1 WP1 Progress

WP Name:	Project management and secondments coordination
WP Leader:	DANAOS

General Work Package Overview and activities:

- Direct Communication to project officer (PO), coordinating and forwarding any partner's request
- Managing secondment plan and secondment execution
- Coordinating physical or virtual (online) communication between partners
- Tracking project progress
- Project's document and administrative management
- Quality checks, reporting, Risk identification, and monitoring

Main Achievements (M1-M12)

In the first year of the project, an internal project management handbook with reporting procedures, project documents, quality and communication plan prepared, approved internally, and monitored throughout the implementation phase. Several technical meetings were conducted either physically or virtually to organize the technical roadmap of the project. Monthly status meetings arranged, and bi-monthly progress reports prepared by WP leaders to track progress, register and assess risks and monitor secondments implementation. In reference to the secondment management, the close coordination of the secondments included reporting of issues and problem solving where needed, facilitation of interactions and recording of research activities and knowledge transfer.

Updates per Task (M12-M36)

T1.1 Administrative project management (Task Leader: DANAOS)

- A virtual project review meeting with the project officer took place at M18. Meeting notes along with results and presentations reported in D1.2.
- An amendment submitted and approved for project extension of 12 months to mitigate delays due to Covid-19 restrictions on traveling that held back the activation of secondments
- Continuous communication with PO to solve issues.
- A change beneficiary request forwarded by ENPC is in progress.
- Bi-monthly progress reports prepared by work package leaders and monthly consortium meetings arranged to track work progress and secondments status, solve issues and assess risks.

T1.2 Secondment coordination (Task Leader: DANAOS)

- Keep track of secondments' progress. Manage execution of the secondment plan and monitor deviations.
- Coordinate and facilitate arrangements between hosting and sending partners.
- Record research activities, interaction and knowledge transfer generated by the secondments. There are dedicated procedures and relevant documentation to report all secondments' details/outcomes constituting project's knowledge repository.

T1.3 Quality assurance and risk management (Task Leader: DANAOS)

- Ongoing assessment of project risks and identification of new threats/opportunities.
- Manage and control quality of deliverables and secondments implementation.

Deviations Issues and Next Steps

Deviations:

- No major deviations and issues to be reported.

Next steps:

- Ongoing day to day project and secondment management including project progress control, administrative coordination, quality and risk management
- Preparation of the project interim report for the 1st reporting period (M1-M36)

2.1.2 WP2 Progress

WP Name:	Requirements elicitation, use case scenarios, and roadmaps for integrated vessel management
WP Leader:	HUA

General Work Package Overview and activities:

- The main objective of WP2 is to set the framework for the envisioned SmartShip platform: the scenarios definition and bidirectional requirement analysis for the ICT-based management of marine vessels will be carried out, focusing on (i) requirements from the maritime point of view and (ii) requirements for the vessel management framework from the sustainable, CE-aware ICT point of view.

Main Achievements (M1-M12)

- 15 user requirements have been identified regarding real-time route monitoring, weather routing optimization and fleet performance monitoring in due time.
- 4 use cases have been identified in due time, namely weather routing optimization, vessel route monitoring, condition-based (predictive) maintenance, and visualization.
- D2.1 is submitted

Updates per Task (M12-M36)

T2.1 Requirements elicitation and analysis (Task Leader: HUA):

- This task had been completed.

T2.2 Scenarios and KPIs definition (Task Leader: DANAOS)

- This task had been completed.

T2.3 Roadmaps for marine vessel management optimization (Task Leader: ENPC)

- Based on the scenarios and requirements provided by T2.1, and T2.2, the sketch of the roadmap for marine vessel management optimization was improved by adding steps linked to the identification of challenges on circular economy principles incorporation in the maritime industry, strategies and circular business models including technical, business and circular parameters.
- Identification and analysis of SmartShip stakeholders was performed for the exploration of long-term collaborations.

Deviations Issues and Next Steps

Deviations:

- No deviation recorded.

Next Steps:

- The WP is considered completed.

2.1.3 WP3 Progress

WP Name:	SmartShip Circular-Economy based functional architecture design
WP Leader:	ENPC

General Work Package Overview and activities:

- WP3 aims to build the functional architecture of SmartShip and incorporate the circular economy principles in the architecture. The activities described during the reporting period constitute the inputs for D3.1

Main Achievements (M1-M12)

- In the first twelve months of the project a high-level definition of the architecture was provided paired with the context of the identified use-cases and scenarios in WP2

Updates per Task (M12-M36)

T3.1 Design and specification of the SmartShip architecture (Task Leader: ITML)

Task 3.1 expires on M36 after the 1st project amendment (while it was started on M10 of the project). The work achieved during this reporting period can be summarised as follow:

- Based on the requirements described in WP2, the functional blocks as well as the algorithms needed for sustainable marine vessel management were identified and specified.
- The general architecture, combining the different components and mechanisms and guidelines for the development work have been provided and reported in the relevant deliverable (D3.1).
- More specifically, in the framework of T3.1 we identified 3 components of the SmartShip Infrastructure: (i) Data sourcing; (ii) Core Systems; and (iii) Users applications. Each component includes individual tools, methodologies and processes towards an integrated SmartShip ecosystem able to offer a multi-layer optimization in the fields of fuel consumption, energy efficiency and emissions control management, in full respect to the implementation of the requirements of maritime sector regulations and taking into account applications of circular economy concepts in the maritime as well.
- All of the above are reported in details in the Del3.1: "SmartShip circular economy-based functional architecture" submitted also on M36 – March 2022.

As for the knowledge transfer point of view, T3.1 research and work required knowledge sharing in: (a) Building a unique architectural framework that supports both the Telecom Functions and the O&M Functions (b) Specification of the system entities and the self-healing, energy efficiency and web-based functionalities that will be integrated in the architecture and (c) Specification of the interfaces and the corresponding signalling protocols for the interactions. In the framework of T3.1 staff has been seconded from ITML to ENPC and conducted work relevant with this task (see Table 1 and Table 4Table 1) for more details).

T3.2 Supporting functionalities for SmartShip (Task Leader: EPS)

- During this task, based on the SmartShip architecture, an analysis concerning technologies to reduce latency and network overhead was accomplished. Innovative solutions for this problem were explored such as state-of-the-art GPUs and edge AI as they can address the latency issue and reduce the data volume.
- Mechanisms to name, address and localize objects in networks of vessels were examined, taking into consideration already used devices that support the electronic mapping services. We noticed that the development of a tool, which can provide different features for addressing, should solve the existing problem. Also, an introduction to use remote sensing through neural network and a machine learning model could solve the problem of object localization.
- Innovative technologies with the use of DHCP to extend the coverage time of nodes were reviewed using existing data. During this task, we analyzed the use of this protocol and effective ways, such as optimization algorithms, to expand the nodes coverage.
- Finally, we investigated technologies for routing protocols including tunnelling through non-IP links. An analysis on the reasons that TCP/IP are considered old protocols is studied as the protocol cannot keep up with new technologies. A combination of tunneling method in combination with IPSEC, L2TP and GRE protocols are reviewed through literature as a solution to address the issue.

T3.3 Circular Economy principles in SmartShip architecture (Task Leader: ENPC)

- During this task, we analysed the increased need for sustainability in the maritime industry, focusing on exploiting energy efficiency, fuel consumption, and emission control optimization procedures regarding the engines' components operation and reusage.
- This task also analysed the requirements to reduce direct and indirect emissions from the shipping sector and sustainable ship recycling to ensure the re-introduction of materials into the cycle to manufacture new products and propel vessels differently.
- Three main circular economy enabling properties of intelligent assets were considered: location, condition, and availability (lca). Including and identifying lca properties in the three components of the SmartShip ecosystem (data sourcing IoT, Core system, and user applications) will determine the parameters for circularity. Moreover, mapping the circular economy principles for energy efficiency, fuel consumption, and emission control optimization will help to accomplish the KPIs defined in D2.1. The outcomes of this task constitute inputs of D3.1: SmartShip circular economy-based functional architecture.

Deviations Issues and Next Steps

Deviations:

- The progress of the WP is going according to the plan

Next Steps:

- D3.1 will be delivered on M36.

2.1.4 WP4 Progress

WP Name:	SmartShip Baseline framework: IoT and advanced data analytics
WP Leader:	ITML

General Work Package Overview and activities:

- Foster knowledge exchange between academic and non-academic experts in the fields of IoT and Advanced Data analytics to be applied in the maritime filed.
- Design and develop of the IoT-based data analytics module of SmartShip, which will be the core of the multi-level optimization of the vessels' operation and management in terms of fuel consumption, energy efficiency, emissions, and circular economy principles.
- All of 3 tasks are ongoing until M48 (March 2023).

Main Achievements (M1-M12)

During the 1st year of the project there were open only T4.1 and T4.2 both from M10. During these three months (M10-M12) the main achievements were:

- The first steps towards the organization of the knowledge exchange between academic and non-academic experts in the fields of IoT and Advanced Data analytics.
- Moreover, the first steps towards the identification and reporting of any market-ready tool and technology already applied in the maritime industry, related to IoT-based advanced data analytics.

Updates per Task (M12-M36)

T4.1 State of the art in Advanced data analytics and IoT Technologies (Task Leader: HUA)

- Work on this package focused on reviewing the state-of-the-art in the fields of IoT and Data Analytics. Specifically, trajectory classification, clustering and anomaly detection techniques in the maritime domain were reviewed. Furthermore, Distributed Stream Management Infrastructures (DSMIs) and the IoT in data handling in the maritime domain were also reviewed in collaboration with involved partners and during the respective secondments for the purposes of the project. Knowledge exchange was realized through the secondments and the final report that was sent to the WP leader and discusses the advances in the respective fields of the maritime industry.

T4.2 IoT-based data analytics tools and technologies applied in the maritime industry (Task Leader: EPS)

- The concept of marine Internet of Things (IoT) has been created and evolved in the last years due to the requirement of building up the communication interconnectivity between the terrestrial part of maritime with vessels or sea-related equipment (i.e., the "things"), as well as among ships to enable different sorts of sea IoT applications and communication infrastructures. Associated IoT innovations expand the examination of existing information through data and metadata analytics.

Big Data analytics tools, such as Tableau, Power BI and Virtualitics, make it possible to analyse these large quantities of data in order to gain the insight that supports decision-making and contribute to logistics optimization, safety and energy efficiency improvement. There are a few IoT related infrastructures that can form maritime industry to more secure and efficient paths. These IoT technologies that are used in Maritime Industry are sensors, M2M, vehicle terminal and robotics automation.

T4.3 Design and Development of Advanced Data analytics module (Task Leader: ITML)

Task 4.3 expires on M48 after the 1st project amendment (while was started on M20 of the project). The work achieved during this reporting period can be summarised as follow:

- Based on the inputs from T4.1 and T4.2, as well as the architecture from WP3 and the requirements from WP2, we proceeded to the design of the IoT-based data analytics module of SmartShip. More specifically, the integrated SmartShip advanced data analytics module will be part of the SmartShip core system as a build-in system function. In SmartShip analytics module, data will be presented in two manners (Source: D3.1):
    - Data insights is the situation awareness data representation field. User quickly grasp the big picture over large volumes of data, makes observation real time, uncover hidden patterns in the underlying data and gain knowledge. Data insights could be consumed through user application interface nearly real time close to the edge of the source (fog layer) thus user on-board will instantly reflect insights to a fast response and decision. Data insights are consumed mostly ashore following data integration mechanisms.
    - Data analytics is the operator-defined algorithmic analysis of fused data. Data analytics are performed ashore (office environment). Analytics allows “hindsight” reflecting and learning from past data by statistical processing of past observations (trend analysis, etc.) and detection of hidden correlations among seemingly un-related data. This is where deep knowledge of various aspects of vessels’ lifecycle is achieved (LCA knowledge base). Analytics gives “insight” interpreting data and responding efficiently to the present by providing KPi’s real time monitoring (operational efficiency, safety performance, etc.), enabling vessel’s benchmarking against theoretical curves. specifications, tests, sea trials and competitors or sisters vessels while triggering timely anomaly detection / alerting for abnormal behavior and deviation from predefined thresholds. Finally, Analytics offers “foresight” predicting and getting ready for future events by activating what-if scenarios (forecasting based on current observations) and performing risk assessment (multi-factor). Apart from user-defined (based on subject expert judgment) algorithms data analytics module enables machine learning AI models for forecasting.
- As for the knowledge transfer point of view, T4.3 research and work required knowledge sharing in: (a) Advanced data analytics and IoT Technologies (b) IoT-based data analytics tools and technologies applied in the maritime industry and (c) Specification of the interfaces and the corresponding protocols for the interactions. In the framework of T4.3 staff has been seconded from ITML to ENPC and conducted work relevant with this task (see Table 1 and Table 4 for more details).

Deviations Issues and Next Steps

Deviations:

- The activities are in line with expectations. No issues, delays or deviations to be highlighted

Next Steps

- We are planning to procced with the module development on the upcoming months in order to have available the first version of the tool around M38-M40
- As soon as a 1st version will be ready, we are going to test it and modify it if necessary so as by M48 to release the final version of the tool which will be the core of the multi-level optimization of the vessels’ operation and management in terms of fuel consumption, energy efficiency, emissions and circular economy principles.

- All of the above will be reported in details in the D4.1: "IoT applied tools and technologies and data analytics module" that will be submitted on M48 – March 2023.

2.1.5 WP5 Progress

WP Name:	SmartShip Decision Support and multi-layer optimization module
WP Leader:	BLS

General Work Package Overview and activities:

The main objectives and activities of WP5 are:

- To organize the knowledge exchange between academic and non-academic experts in the fields of decision support and optimization in terms of energy efficiency and emission control in the maritime field.
- To identify and report any market-ready tool and technology already applied in the maritime industry, related to decision support and optimization in terms of energy efficiency and emission control in the maritime field. The report will include the potential customization required for the aforementioned tools, to meet requirements of SmartShip as defined in WP2.
- Design and development of the decision support module of SmartShip, that will be the core of multi-level optimization of the vessels' operation and management in terms of fuel consumption, energy efficiency, emission, and circular economy principle.

Main Achievements (M1-M12)

During the 1st year of the project only T5.1 was running (from M10). During these three months (M10-M12) the main achievements were:

- The first steps towards the organization of the knowledge exchange between academic and non-academic experts in the fields of decision support and multi-layer optimization technologies and,
- The first steps towards the identification and reporting of any market-ready tool and technology already applied in the maritime industry, related to decision support and multi-layer optimization technologies.

Updates per Task (M12-M36)

T5.1 State of the art in Decision Support and multi-layer optimization Technologies (Task Leader: ENPC)

- ENPC proposed the structure for knowledge exchange in the fields of Decision Support and Optimization in terms of energy efficiency and emissions control in the maritime field. The structure includes a state-of-the-art report based on the technical details defined during the requirements elicitation and analysis (D2.1) that summarizes recent advances in these fields.

T5.2 Decision support and optimization tools and technologies applied in the maritime industry (Task Leader: BLS)

- The internal report about the market ready maritime application has been prepared
- Discussion of the improvement vectors in existing application has been started
- Established the road map for the next task have been prepared

T5.3 Design and Development of Data analytics and Decision Support module (Task Leader: BLS)

- BLS gathered (compiled) the knowledge on requirements from WP2, architecture -WP3 as well as T5.1, T5.2; in order to prepare roadmap towards the development of data analytics and decision Support module.
- BLS researched together with HUA on prediction models such as ARIMA, PROPHET, LSTM led to identification of the most efficient methodology.

Deviations Issues and Next Steps

Deviations:

- Covid restrictions impacted knowledge exchange in T5.1 and T5.2.

- Covid restrictions impacted work in T5.3

Next Steps:

- According to new plan we are going to proceed the task T5.3 and deliverable until M46 - march 2023.

2.1.6 WP6 Progress

WP6 starts in M37 of the project timeline

2.1.7 WP7 Progress

WP Name:	Dissemination, exploitation and training management
WP Leader:	ENPC

General Work Package Overview and activities:

- WP7 involves the coordination, management, and execution of the dissemination, exploitation and training activities for efficient binding the maritime industry with ICT-oriented industrial and research beneficiaries. It also manages the basic networking and knowledge-sharing activities of the project.

Main Achievements (M1-M12)

- Participation in several dissemination and communication activities
- Active presence in social media channels and website
- Participation in the Horizon Results Booster services proposed by the EC: Portfolio Dissemination & Exploitation Strategy
- Researchers nomination for MSCA Fellow of the week
- Application for Climate Pact Ambassador and Organizational Climate Pledge accepted
- Publications
- Preparation and submission of D7.1

Updates per Task (M12-M36)

T7.1 Dissemination management (Task Leader: ENPC)

- Implementation of SmartShip dissemination activities including an update on the definition and analysis of target audiences.
- Dissemination activities during this period included: seven research publications in journals and conferences, continuous update of the SmartShip website and social media with the publication of information on the project activities, news, presentations, flyers, videos, interviews, and a policy brief.
- Four workshops were organized: two external and two internal (see section 6.2.1.1).

T7.2 Exploitation management (Task Leader: ENPC)

- Initial individual exploitation plans remain as described in D1.1.
- Definition of joint exploitation plans and the emergence of synergies between partners regarding the technical components will be supported by developing at least two exploitation workshops. The exploitation approach will consider different methods, including commercial licensing, open-source projects, integration with existing products or services, and developing particular software components with startups. The stakeholder analysis in T2.3 and T7.1 are also part of the exploitation activities that help understand the actors and key partners of the various value chains in the maritime sector. The analysis of the possible exploitation paths will also include the new circular economy standards (ISO TC 323).

T7.3 Training management & material development (Task Leader: HUA)

- On M34, the first training session of the SmartShip project took place at Harokopio University of Athens. Despite the fact that the new covid restrictions did not allow for a full physical meeting, a hybrid training session was held where 21 people from SmartShip partners gathered either virtually

or physically to learn about novel methodologies of storing and querying trajectory data and developing micro-services. (read more in 6.4.1)

Deviations Issues and Next Steps

Deviations:

- Due to covid restrictions, online dissemination activities were prioritized during the reported period.
- The covid restrictions imposed by the governments did not allow for a full physical training event and a larger audience. Nonetheless, we are planning to organize training event(s) in the future, which are expected to be entirely physical and will attract more people.
- Due to the extension of the project, the exploitation workshops will be organized during the fourth and fifth year of the project (Figure 1).

Next Steps:

- Enhance dissemination activities
- Monitor exploitation strategy and realize benefits through dedicated exploitation workshops
- Follow training management plan

3. Secondment Reporting & Knowledge Transfer

3.1 Secondment Reporting

Considering the rollout of secondments up to the 3rd year of project implementation, a consolidated list of **actual** secondments is displayed below (Table 1). The status of each secondment has been defined and some of them are linked to the corresponding post in the SMARTSHIP website with the content of the secondment and a reference to the conducted research activities. ***Ongoing*** secondments are marked in orange for easy reference.

Table 1: Submitted SmartShip Secondments (M1 – M36)

Sec. No.	Fellow. Id.	Secondee Name	Sending partner	Receiving Partner	Sec. Start Date	Duration	WP	Report
1	1	Piotr Kowalksi	BLS	HUA	1/7/2019	2.87	7	SUBMITTED
2	2	Jakub Rola	BLS	HUA	5/7/2019	3.03	7	SUBMITTED
3	3	Markos Bonazountas	EPS	HUA	29/04/2019	1.03	7	SUBMITTED
4	6	Marinos Tsantekidis	TUBS	ITML	17/04/2019	1.13	2	SUBMITTED
5	8	Hernan Ruiz	ENPC	ITML	1/11/2019	4	2	SUBMITTED
6	7	George Alexandris	ENPC	ITML	1/11/2019	2	2	SUBMITTED
7	9	Vlatka Katusic	ENPC	ITML	1/11/2019	4	2	SUBMITTED
8	10	Antonios Makris	HUA	EPS	19/07/2019	5	2	SUBMITTED
9	11	Sofia Alexaki	ENPC	ITML	15/12/2019	3.03	3	SUBMITTED
10	12	Anastasia Vayona	ENPC	DANAOS	9/2/2020	4.03	5	SUBMITTED
11	13	Ioannis Kontopoulos	HUA	DANAOS	9/1/2020	5	2	SUBMITTED
12	14	Evangelia Chavele	ITML	ENPC	20/01/2020	6.13	7	SUBMITTED 2nd link 3rd link
13	16	Antonios Tarantilis	ITML	ENPC	20/01/2020	6.13	4	SUBMITTED 2nd link 3rd link
14	15	Aristea Kontaloni	ITML	ENPC	20/01/2020	6.13	3	SUBMITTED 2nd link 3rd link
15	4	Vasileios Prevelakis	TUBS	ITML	9/12/2019	1	2	SUBMITTED
16	6	Marinos Tsantekidis	TUBS	ITML	1/12/2019	1	2	SUBMITTED
17	3	Markos Bonazountas	EPS	HUA	4/11/2019	3.6	7	SUBMITTED
18	17	Despina Kallidromitou	EPS	ENPC	30/01/2020	6.03	3	SUBMITTED 2nd link
19	19	Thekla Kafatari	HUA	DANAOS	5/8/2020	1	4	SUBMITTED
20	20	Alexandros Papadopoulos	EPS	HUA	1/4/2020	4	4	SUBMITTED
21	21	Avraam Mavridis	EPS	HUA	3/8/2020	8.93	4	SUBMITTED
22	2	Jakub Rola	BLS	HUA	13/09/2020	2.2	5	SUBMITTED

23	22	Rafał Szustkiewicz	BLS	HUA	16/11/2020	8.77	5	SUBMITTED
24	7	George Alexandris	ENPC	ITML	16/01/2021	5	4	SUBMITTED
25	9	Vlatka Katusic	ENPC	DANAOS	15/03/2021	5	3	SUBMITTED
26	12	Anastasia Vayona	ENPC	ITML	1/3/2021	4	5	SUBMITTED
27	11	Sofia Alexaki	ENPC	ITML	15/05/2021	6	5	SUBMITTED
28	18	Dimitrios Panos	BLS	ENPC	5/7/2021	2.07	7	SUBMITTED
29	12	Anastasia Vayona	ENPC	BLS	27/9/2021	3.97	2	SUBMITTED
39	30	Ioannis Korontanis	HUA	DANAOS	1/10/2021	5	5	SUBMITTED
30	23	Anna Maria Anaxagorou	ITML	ENPC	10/1/2022	3	3	ONGOING
31	23	Anna Maria Anaxagorou	ITML	ENPC	10/4/2022	0.9	4	ONGOING
32	24	Spyridoula Vlataki	ITML	ENPC	10/1/2022	3.9	4	ONGOING
33	25	Miriam Bagni Siwale	ITML	ENPC	10/1/2022	3.9	4	ONGOING
34	29	Mateusz Kamiński	BLS	HUA	24/01/2022	2.27	5	ONGOING
35	2	Jakub Rola	BLS	HUA	4/1/2022	2.97	5	ONGOING
37	27	Fotios Oikonomou	DANAOS	ENPC	8/12/2021	3.8	3	ONGOING
38	28	Panagiota Arampatzi	DANAOS	HUA	1/11/2021	5	2	ONGOING
38	26	Stamatios Arkoulis	DANAOS	ENPC	8/12/2021	3.8	2	ONGOING

It should be noted that each completed secondment is reported in an officially defined template including details of the secondment, descriptions of research activities and results. The reports are stored, controlled and managed in our project repository (Dedicated google drive folder). The template is displayed for easy reference in **Annex I**.

3.2 Project Secondment Plan Progress

By aggregating number of person months (PM) spent per partner for secondments (refer toTable 2), we come up with below picture (Table 3) which portrays a comparison of actual research effort in secondments of each partner dedicated to each WP versus estimated as stated in the DoA. Specifically, actual total number of PMs spent, is measured and recorded both in reference to each partner and each work package. Percentage of actual effort deviations against planned for secondments from M1 – M36 of the project is given again per WP and per partner.

Table 2: Planned SmartShip Secondments (M1 – M36)

Secondments Plan (M1-M36) according to DOA								
Initial allocation (Duration in months)								
WP	DANAOS	HUA	ENPC	ITML	BLS	EPS	TUBS	Total
WP2	10	10	19	0	0	0	3,13	42,13
WP3	4	0	15	10	6	6,03	0	41,03
WP4	0	7	5	13,99	1,34	12	0	39,33
WP5	0	12	4,03	0	18	0	0	34,03
WP6	0	0	0	0	0	0	0	0
WP7	3	6	0	6,13	5,9	4,63	0	25,66
Total	17	35	43,03	30,12	31,24	22,66	3,13	182,18

Table 3: Actual SmartShip Secondments (M1 – M36)

Secondments Actual Implementation & Deviations (M1-M36)									
Actual Implementation (Duration in months) - DECLARED IN ECAS (submitted & draft)									
WPs	**DANAOS**	**HUA**	**ENPC**	**ITML**	**BLS**	**EPS**	**TUBS**	**Total**	**Deviation/WP M1-M36 (Actual/Planned)**
WP2	7	10	13,97	0	0	0	3,13	34,1	-19%
WP3	3,8	0	8,3	9,13	2,07	6,03	0	29,33	-29%
WP4	0	1	5	14,83	0	12,93	0	33,76	-14%
WP5	0	5	17,12	0	16,21	0	0	38,33	+13%
WP6	0	0	0	0	0	0	0	0	-
WP7	1,8	0	0	6,13	5,9	4,63	0	18,46	-28%
Total	12,6	16	44,39	30,09	24,18	23,59	3,13	153,98	-15%
Deviation/ Partner (M1-M36)	-26%	-54%	+3%	0%	-23%	+4%	0%		

It is noted that the actual secondment plan is **not significantly** lagging behind from initial plan for the respective period (deviation of 15%). The only significant deviation is recorded in HUA's secondment execution against the planned (54% against the plan). This is mostly due to the reallocation of HUA secondments dedicated to WP4, WP5 and WP7 to a later stage of the project. On the other hand, this deviation did not have any negative impact to an efficient and successful delivery of work as planned for the respective work packages until M36. This is reflected in the minor deviation/WP percentages as displayed in the relevant column with the exception of WP3 (-29%) and WP7 (-28%). The WP3 is finished in M36 according to the project schedule but still there are some opening secondments that are not incorporated in the calculations for this report thus the final deviation is expected to be less. In respect to WP7 any negative deviation is expected to be ameliorated as workshops and trainings are progressed. The status of secondments and technical work will be thoroughly recorded in the forthcoming interim report for the 1st reporting period (M1-M36)

3.3 Secondments' Knowledge Transfer and Research activities up to M36

In this section, the research performed and the corresponding results are presented in a consolidated format (Table 4) as output of the completed secondments activated in the period M1-M36. The report is aggregating for each work package the associated secondments conducted (in reference to table 1) presenting the interaction between the hosting party and the seconded staff, the research activities performed within the context of the relevant tasks as well as the artifacts or outcome produced out of these interactions. This report in tabular format is representing the research as stemming only from the completed secondment at the time of this deliverable preparation. Ongoing secondments (see list of ongoing secondments in table 1, in Section 3.1) due to be completed in the near future or later in the project, thus not yet reported in the internally official document (see Annex I), are not included.

Table 4: Secondments' research activities and results (M1-M36)

Related WP	Secondments			Knowledge Transfer	Main Research Activities	Relevant Task(s)	Results
	From	To	No.				
WP2	TUBS	ITML	4,15, 16	**TUBS** shared • expertise in tools and techniques for efficient collections, classification and documentation of users requirements • expertise in techniques for use cases design framework • knowledge for technology trends in Cyber threats and Security in Maritime management/operation **ITML** shared • Knowledge in maritime ICT products (market analysis) • Knowledge in maritime ICT products dedicated to energy efficiency and emission reductions in an integrated fleet management perspective • expertize in data analytics	• Market Analysis and collection of requirements based on focus groups, interviews and surveys for SmartShip Use cases • Use Case definition and analysis • Elicitation of ICT-based functional requirements for SmartShip framework • Working on D2.1 • Participation in technical meetings	T2.1, T2.2	➢ SmartShip **use cases** ➢ **Scenarios definition** to validate SmartShip framework ➢ **Actors and roles** in SmartShip use cases ➢ **KPIs** identification ➢ SmartShip framework as a **Circular economy system** ➢ Report and documentation of the research results in **D2.1**
	ENPC	ITML	5,6,7	**ENPS** shared • Knowledge in Circular economy principals • Expertise in designing sustainable frameworks • Use case evaluation and validation techniques and methodologies **ITML** shared • Knowledge on environmental Performance indicators in vessel management • Knowledge on ICT-based KPI's for validation of a circular economy by-design SmartShip framework	• KPIs identifications • Use case scenarios design fused with circularity principals • Incorporation of Circular Economy concept in Vessel management • Investigation was performed with respect to targeted reuse of ship-native data for predictive maintenance purposes (Engine lifecycle data, aggregation of data in a cloud environment and application of data analytics • Identification of the different stakeholders in the maritime	T2.2, T2.3	

					industry as well as the identification of the existent technologies for ships data management • Working on D2.1 • Participation in technical meetings		
	HUA	EPS	8	**HUA** provided • Expertise in geo-spatial data processing for extracting maritime traffic patterns. **EPS** shared • Knowledge on existing approaches for optimization of voyage planning and route monitoring	• Building use cases for voyage management optimization in the framework of the SmartShip platform • Working on D2.1 • Participation in technical meetings	T2.2, T2.3	
	HUA	DANAOS	11	**HUA** brought • Intelligence in algorithm formulation for value driven applications in vessel management in cases such as preventive maintenance and vessel route planning **DANAOS** provided • Business logic for the definition of use cases • Maritime specific requirements for vessel management optimization • Compliance standards and governance framework in the maritime industry for energy efficiency and emission control	• Maritime specific user needs translated into functional requirements in the SmartShip framework • Definition of scenarios and KPIs to be tested and assessed in SmartShip platform • Roadmap for marine vessel management optimization • Working on D2.1 • Participation in technical meetings	T2.1, T2.2, T2.3	
	ENPC	BLS	29	**ENPC** provided • Expertise in Circular economy standards **BLS** presented • pairing of cutting-edge technologies and circular economy principals for vessel management optimization	• Roadmap for marine vessel management optimization • Identification of shipping industry stakeholders • Working on D2.1 • Participation in technical meetings	T2.3	
Related WP	**Secondments**			**Knowledge Transfer**	**Main Research Activities**	**Relevant Task(s)**	**Results**
	From	To	No.				

WP3	ENPC	ITML	9	**ENPC** shared • techniques and models for circular economy standards in complicated technology applications • knowledge and standards for a Circular economy by-design maritime operation **ITML** shared • knowledge in protocols and methodologies for interfaces between distinct systems in an integrated framework • expertise in specifications and design of technical requirements for a solid integration of system's functional components	• Identification of the specification of the system entities and the self-healing, energy efficiency and web-based functionalities that will be integrated in the SmartShip architecture • Working on the Specification of the interfaces and the corresponding signaling protocols for the system interactions • Design of the incorporation of Circular Economy principals in the SmartShip Framework such as: 1. Re-thinking business models and solutions at every level to be mindful of resource use and waste production; 2. Reduce consumption of energy and materials by applying lean design principles and producing products that are made to last;3. Reuse products by transferring them to another user; 4. Repair components and parts so that products can be used longer by the user; 5. Refurbish: To achieve circular economy, businesses can look into recovering and refurbishing old products to be sold again or transformed in new products; 6. Recover embedded energy from non-recyclable waste material where feasible; 7. Recycle materials or resources by disassembling components and separating parts.	T3.1, T3.3	➢ Design and specification of **the SmartShip architecture** ➢ Identification of **the Supporting functionalities** for SmartShip ➢ Definition **of the Circular Economy principles** in SmartShip architecture ➢ Presenting the SmartShip **circular by design architecture** in **D3.1**

					• Working on D3.1		
	ITML	ENPC	14	**ENPS** shared • expertise for sustainable ICT frameworks **ITML** provided • knowledge of marine specific algorithms for sustainable vessel management • expertise in developing smart web-based applications • experience in ICT architecture designs	• Designing SmartShip architecture to support all identified functionalities • Setting the specifications of the system entities and the self-healing, energy efficiency and web-based functionalities that will be integrated in the SmartShip architecture • Set-up of a web-based design for the SmartShip platform • Defining compliance of a SmartShip architecture with Circular economy principals • Working on D3.1	T3.1, T3.3	
	EPS	ENPC	18	**EPS** provided • knowledge in internet protocols and network management optimization techniques as applied and configured in vessel's communications • experience in life cycle analysis methodologies **ENPC** shared • techniques and methods for sustainable configuration of ICT systems	• Building and designing the communication and connectivity framework of the SmartShip system	T3.2	
	ENPC	DANAOS	25	**ENPC** shared • methodologies and standards for circular economy incorporation in an ICT architecture design **DANAOS** demonstrated • the developed in-house and maritime specific ICT tools currently in-use by the DANAOS users • knowledge on a marine-specific system architecture comprising of interconnected	• Definition of SmartShip architecture based on existing DANAOS ICT tools • Designing circular economy in SmartShip arcitecture • Working on D3.1	T3.1, T3.3	

				and integrated functional components supporting a sustainable fleet management.			
Related WP	**Secondments**			**Knowledge Transfer**	**Main Research Activities**	**Relevant Task(s)**	**Results**
	From	To	No.				
WP4	ITML	ENPC	13	**ITML** shared • expertise in big data analysis and processing • expertise in IoT system's network configuration **ENPC** shared • knowledge on circular economy deployment in data processing-usability-exploitation	• Research on state of the art in advanced data analytics and IoT technologies	T4.1	➢ **Reporting on the state-of-the art** in **advanced data analytics** and **IoT** technologies ➢ **Market research** in existing maritime specific data analytics tools and on-board IoT network applications ➢ **Exploration** of DANAOS analytics module and **identification of potential customization** ➢ **Initial design of SmartShip** data analytics module ➢ **Internal document reporting results of** the research
	HUA	DANAOS	19	**HUA** demonstrated • research in techniques for geo-spatial data clustering and processing for vessel routing and marine traffic management **DANAOS** shared • expertize in the development and exploration of existing data analytics tools and IoT technologies applied in the organization and used internally	• Reporting on market-ready tool and technology already applied in the maritime industry, related to IoT-based advanced data analytics • Exploring state of the art in advanced data analytics • Gap analysis and identification of potential customization over the existing tools utilized by DANAOS	T4.1, T4.2	
	EPS	HUA	20,21	**EPS** provided • demonstration of smart applications for life cycle analysis in the vessel operation and maintenance • experience in an IoT vessel's network configuration on-board **HUA** shared • Knowledge on data sourcing, classification and processing	• Research on the state of the art in advanced data analytics and IoT technologies applied in maritime industry	T4.1. T4.2	
	ENPC	ITML	24	**ENPC** shared • concepts and directions for a sustainable circular design of an advanced data analytics module **ITML** provided	• Initial configuration and design of the SmartShip data analytics module • Introduction of data-driven circularity properties in the	T4.3, T4.2	

				• design principals and development techniques for a maritime specific data analytics module	business flows in the forms of process metrics which aim to quantify circularity, such as: 1. End-of-Life indexes for assessing performance of IoT-monitored components used within the flow boundaries, mainly for disassembly and recovery of used components. This metric was analyzed for business flows pertaining to maintenance and repairs; 2. Material Circularity indicators, measuring added value from circular activities which stems from the actual flow operations outcomes and real-time data. This particular metric was also examined for maritime flows involving procurement or investment decisions involving circular practices; 3. Recycling Benefit rate, depicting the environmental impact of utilizing recycled resources as opposed to virgin ones. Here, it was explored how data analytics-driven dashboards can showcase the benefits of recycling for the business flow participants and to the public in general. • High-level directions for enhancing technological tools for maritime business process monitoring were identified. The aim of the enhancements were to amplify the circularity of the processes		related to WP4 activities

Related WP	**Secondments**			**Knowledge Transfer**	**Main Research Activities**	**Relevant Task(s)**	**Results**
	From	To	No.				
WP5	ENPC	DANAOS	10	**ENPC** shared • circular economy standards and sustainable design principals in the fields of decision support and optimization in terms of energy efficiency and emissions control **DANAOS** offered • expertise in intelligent decision support systems applied for a sustainable maritime operation	• Identification of the State of the art in Decision Support and multi-layer optimization technologies applied in the maritime industry. • Regular meetings and collaboration with experts in decision making technologies for smarter energy consumption in the maritime sector. • Identification and prioritization of the research in efficient fuel consumption and emissions control; data-driven approach for fine grained tuning of energy consumption, in order to increase the energy efficiency was conducted.	T5.1, T5.2	➢ **Reporting on the state-of-the art** in Decision Support and multi-layer optimization Technologies ➢ **Market research** in existing maritime specific technologies related to decision support systems and optimization ➢ **Exploration** of DANAOS decision support module and **identification of potential customization** ➢ **Initial design of SmartShip** decision support module ➢ **Internal document reporting results**
	BLS	HUA	22,23	**BLS shared** • the knowledge of agile form of managing technology projects and how to work with SCRUM framework, with market ready tools like JIRA, in favor of managing efficiently the development of ICT tools **HUA** transferred • an in-depth knowledge of the maritime industry in terms of hot technology trends, legislation, regulation and applied international laws as well as standards used in maritime industry which should be taken into consideration while configuring data analytics and rule-based decision support systems	• Conducted investigation of identifying the most precise methodology of vessels trajectory for an effective support and useful advice to the captain on-board in the decision making for the vessel's route plotting and monitoring including: 1.**ARIMA** (Auto Regressive Integrated Moving Average) – the model provides a complementary approach to time series forecasting and is	T5.1, T5.3	

					one of the most widely used methodologies. Its key purpose is to describe autocorrelations in the data; 2. **PROPHET** – this algorithm detects the trends and seasonality patterns from the dataset first, then combines them together to arrive at the forecasted values; 3. **LSTM** (Long Short Term Memories) – the model refers to Recurrent Neural Networks and is used to track the dependencies of new observations with historical ones. It requires a large volume of data.		**of** the research related to WP5 activities
	ENPC	ITML	26,27	**ENPC** provided • knowledge on the state-of-the art in sustainable design principals and optimization techniques in advanced technologies **ITML** shared • knowledge on market-ready tools and technology already applied in the maritime industry for digital decision support to maritime actors in regard to energy efficiency, fuel consumption and emissions control	• Documenting optimization techniques and reporting decision support and optimization tools and technologies applied in the maritime industry	T5.2, T5.1	
	HUA	DANAOS	39	**HUA** shared • Intelligence in building-up smart algorithms • Knowledge in development of data processing and analysis **DANAOS** provided • Demonstration of existing services for digital support in the decision making for critical maritime operations	• Design of a data exchange protocol between HUA algorithms and DANAOS services • Incorporation of research results into DANAOS existing digital tools for data analytics and decision-making support. To this end an API developed to bridge HUA algorithms/methodologies and DANAOS services	T5.3	

Related WP	Secondments			Knowledge Transfer	Main Research Activities	Relevant Task(s)	Results
	From	To	No.				
WP7	BLS	HUA	1,2	During all the secondments related to the exploration dissemination and training management of SmartShip project, **all partners exchanged** ideas, concepts, methodologies, relevant expertise, and knowledge • on training management techniques, • in business approaches for effective commercialization of project results, • on effective organization of project promo activities • on the preparation and publication of scientific concepts related to project research.	• Conducting review of subject literature • Cross-fertilize knowledge with the entire project team • Establishing contacts with relevant business and research entities for future collaborations • Collaborating on the write-up and publishing of papers relevant to SmartShip research content • Organizing and participating in events presenting and communicating SmartShip results, objectives and research priorities, • Preparing training material and arranging dedicated training activities • Promoting SmartShip through networking channels. Reaching out research audience through social media and exposing project achievements through SmartShip website	T7.1, T7.2, T7.3	➢ **SmartShip website** development and management ➢ **SmartShip promotion** via **open communication channels** (social media, conferences, exhibitions, forums, etc). ➢ Organization of **the 1st SmartShip training event** ➢ Establishment **of joint research initiatives** (participation in the project group BigMobilityData) and collaboration with similar EU project (e.g. Data ports)
	EPS	HUA	3,17				
	ITML	ENPC	12				
	BLS	ENPC	28				

							WP7 results are further elaborated and presented in section 6 .

4. Project Deliverables and Technical Progress

4.1 List of Deliverables

In below Table 5, a list of deliverables submitted by M36 is presented. Any issue or deviation observed is recorded.

Table 5: List of Deliverable (M1-M36)

Deliverable No.	Description	Lead Partner	Type	Dissemination Level	Due Date	Submission Date	Comments
7.1	Data Management Plan	ENPC	ORDP: Open Research Data Pilot	Confidential, only for members of the consortium (including the Commission Services)	30/9/2019	1/10/2019	A non-critical delay of 1 day in official submission of the final version to the EU portal occurred
2.1	SmartShip requirements analysis, scenarios and KPIs definition	HUA	Report	Public	31/12/2019	29/12/2019	On time delivery
1.1	First year progress report including initial exploitation, dissemination and training plans	DANAOS	Report	Public	31/3/2020	15/4/2020	Slight deviation of 15 days. Covid-19 caused some delays in aggregating reports and results from all partners for the respective period
1.2	Mid-term project meeting	DANAOS	Other	Public	31/5/2020	25/10/2020	This was deliberately postponed for 5 months since this is the follow-up report of the mid-term meeting conducted with the project officer on 18/9/2020 (M18)
3.1	SmartShip circular economy-based functional architecture	ENPC	Report	Public	31/3/2022	N/A	This is due to be delivered on M36 in parallel submission with D1.3. A slight delay is expected but not significant. A last time technical re-configuration of

							some components of the architecture is expected to result in delaying the submission for a few days

4.2 Project Technical Progress

Given that no issues or deviations on WP progress or any delay on deliverables' submission have been noticed so far, it is concluded that actual technical progress is aligned with planned for the first 36 months of the project. Project is on schedule against work-plan baseline as being revised after the approved extension of 12 months moving project end month from M48 to M60. In percentage, approximately 60% of project work is completed which is equal to more than half of the overall technical effort as projected to be consumed up to the third year of SmartShip (60 Months duration). Below Table 6 is quantifying completion percentage by each task giving an aggregated average per WP.

Table 6: Percentage Completion per Task

Task	Mst	Mend	Duration	Completion %M36
1.1	1	60	60	60%
1.2	1	60	60	60%
1.3	1	60	60	60%
2.1	1	9	9	100%
2.2	1	9	9	100%
2.3	10	36	27	100%
3.1	10	36	27	100%
3.2	10	36	27	100%
3.3	19	36	18	100%
4.1	10	48	39	65%
4.2	10	48	39	65%
4.3	20	48	29	55%
5.1	10	48	39	65%
5.2	10	48	39	65%
5.3	20	48	29	55%
6.1	37	54	18	0%
6.2	42	56	15	0%
6.3	37	41	5	0%
6.4	42	60	19	0%
7.1	1	60	60	60%
7.2	1	60	60	60%
7.3	1	60	60	60%

5. Risk Analysis and Corrective Measurements

Following, we display a list of risks and mitigation actions as identified in DoA (Table 7). Where necessary, we provided a revised corrective plan, and we indicate if any corrective action has been materialized along project development until M36.

Table 7: Risk Analysis as per DoA

Risk Number	Description of Risk	Mitigation Measures as DOA	Revised Mitigation Measured	Risk Materialized
1.	Underperforming partner	All consortium partners are highly committed to the project, and it is unlikely to expect this situation. If it	Not Revised	Not Materialized

		occurs, the flexible project management structure and Consortium Agreement allow a quick shift of resources to alternative project partners.		
2.	Partner leaving the project	In this unlikely case, it would only have a temporarily disruptive effect, as the consortium is well-balanced, and the affected tasks can be allocated to another partner. Otherwise, the flexible management structure allows quick inclusion of new partners in the consortium if necessary.	Not Revised	**Materialized:** ENPC is leaving the project (an amendment of beneficiary termination is in progress at the time of this deliverable preparation). This issue was responded with the inclusion of a new partner as project beneficiary. The new partner is an affiliated organization with ENPC and has the background and skills to take over all the remaining tasks of the leaving organization.
3.	Keyperson left or is temporarily not available	Consortium partners are involved in the related areas with more than one staff member, ensuring an immediate substitution. Furthermore, the project as whole has technical excellence in related disciplines spread across the partners, providing additional substitution possibilities.	Not Revised	Not Materialized
4.	Needed partners' resources are underestimated	In this case, the project management bodies will analyse the following possibilities to ensure that planned work can be completed: (i) rearranging resources among the partners as needed, (ii) committing further internal resources of organizations in project activities (if possible), and (iii) re-planning work on the activities in accordance with previous measures.	Not Revised	Not Materialized
5.	Project schedule is partly not appropriate	The project management structure and measures continuously monitor performed work vs. project plan and are entitled to perform corrective actions – change of the project plan – if necessary, which also apply for this case. In crucial cases, the PM will work on the plan adaptation in close cooperation with EC.	Not Revised	Not Materialized
6.	Project milestones or deliverables are delayed	In the scope of project management monitoring activities, detailed analysis will be done on both global project and lower (WP/Task) project implementation levels. Thus, it will be ensured that such cases are recognized in early	Not Revised	Not Materialized

		stages, ensuring timely and effective implementation of necessary corrections in the work plan.		
7.	Agreement among partners is difficult to achieve	The collaboration spirit in the consortium targets to achieve consensus among all partners on the open issues and the project management bodies will work in this direction. However, in order to avoid a lengthy consensus making processes, which might affect the project plan, the related management procedures for decision making and conflict resolution will be timely applied.	Not Revised	Not Materialized
8.	Not satisfactory interaction among WP's and tasks	The regular synchronization of work among WP's will be performed in the scope of project management activities; so these cases should not occur or are timely recognized allowing implementation of corrective actions without impact on the project plan. If the problem persists, the PM together with WP leaders will analyse problems and propose procedures for interactions improvement.	Not Revised	Not Materialized
9.	Necessary coordination level in secondment is not achieved	Similar as it will be done for monitoring of the technical project activities, including analysis of work done and implementation of the corrective actions, the project coordination and management will be observed as well. Thus, if necessary, the responsible management bodies will propose the corrective actions improving overall project coordination. If needed, management of the Coordinator organization will be involved to solve the problems.	Not Revised	Not Materialized
10.	Problems in integrating components in once platform	An agile approach has been proposed for the SmartShip implementation lifecycle to ensure efficient integration; SmartShip technical partners have significant expertise in platforms' integration.	Not Revised	Not Materialized
11.	Low technical quality of deliverables	Addressed through regular quality reviews and assignment of peer reviews for each deliverable.	Not Revised	Not Materialized
12.	Underperformance of technologies and optimisation tools delivered	The Agile approach in the design and development phase, as described before, will ensure that the final developments meet the requirements defined in WP2 and the relevant KPIs.	Not Revised	Not Materialized
13.	Not enough external parties reached to SmartShip knowledge	Several different/ complementary activities have been planned (training sessions, workshops, conferences etc.) to ensure that the wider public is efficiently reached and the SmartShip knowledge is disseminated.	Not Revised	Not Materialized
14.	Delays in participants administrative achievements	A workplan and guidelines, including a set of procedures and templates, will become available for all partners within the consortium at the beginning of the project.	Not Revised	Not Materialized
15.	Staff turnover	All participants will identify additional personnel with the necessary experience - not initially intended to be seconded in the project work - so that the risk is minimized.	Not Revised	Not Materialized
16.	Delay in the implementati	The consortium has allocated a partner organisation as secondments manager (SM) (ENPC), which will closely monitor secondments' implementation in terms of the	Not Revised	**Materialized:** There have been noticed

	on of secondments	accuracy and efficiency of the planned and implemented actions. In addition to this, each partner will have a designated person at the level of each participant to ensure smooth implementation of secondments. The SM will organise Skype meeting every 2 months with the Project Coordinator and the designated persons to discuss the monitoring of the secondments and collect any information about possible identified delays at the participant level. Each participant takes responsibility that the secondments will take place as planned and reports within 2 months prior to the scheduled secondment to the SM. Once a potential delay is identified, action plans will be agreed at Consortium level and the Coordinator will inform the REA about the solution found. A chapter specifically dedicated to this risk and the methods to implement upfront monitoring and continuous reporting will be included in the Consortium Agreement and in the Partnership Agreement accordingly.		rearrangement of initial secondment plan for all partners. SM and Project Coordinator assuring (and keep monitoring) that all these amendments are in line with the safe execution of the designated work-plan.

Below a table (Table 8) is portraying new risks not recorded in DoA but identified between M12 and M36 together with corrective measurements applied.

Table 8: Risks Identified (M12-M36)

Risk Number	Description of risk	Corrective Measure	Risk Materialized
17.	Due to unforeseen emergency associated with COVID-19 outbreak in Europe there will be significant delays or changes in secondment plan execution due to the applied restrictions in travelling imposed by the local authorities. This will also cause significant delays in smooth delivery of anticipated project results.	Corrective Measures of Risk No16 (see table 12) are applied. On top of that and given the extent of this force majeure issue and the degree of severity of implications to project progress, an extension to project time-plan will be considered by the consortium.	Materialized: The issue was responded. Consortium submitted a request for 12 months extension of project's duration which was approved by EC. This extension permits partners to safely execute secondments and deliver work and results on-time with the requested quality standards

6. Dissemination, Exploitation and Training Plan

The overall objective of this section is to define the dissemination, exploitation, and training plan for the SmartShip project. SmartShip will conduct a comprehensive and continuous verification and validation of the SmartShip strategy covering operational, technical, business, and legal terms through use cases in the maritime domain.

This section provides a detailed overview of the different stakeholders, and the strategy for dissemination activities. Moreover, it defines the individual exploitation objectives set by each partner of the consortium. The key actions to disseminate the main results and to collect feedback from different stakeholders includes the development of training sessions, exploitation workshops, and events.

Exploitation workshops will help defining and aligning the exploitation plan, technical and business requirements. The training plan seeks to ensure an appropriate transfer of knowledge among the partners and within the different stakeholders involved in the development of the SmartShip framework.

Finally, records for the dissemination activities during the third year of the project are presented.

6.1 Dissemination

During the reported period, the SmartShip project was invited to be part in the project group BigMobilityData and participate in the Service 1 "Portfolio Dissemination and Exploitation Strategy (PDES)", Module A: Identification and creation of the portfolio of R&I project results from the Horizon Results Booster.
Therefore, we received professional support in the process and the production of material from TrustIT[1] (a company performing quality ICT market research and result-oriented stakeholder, communication and engagement strategies). ENPC communicated the results from SmartShip to be promoted for the production of dissemination material including flyers and other captivating solutions like videos, interviews, policy briefs, etc. The results are detailed in Section 6.1.2

6.1.1 Stakeholders

In Table 9 the SmarthShip's identified stakeholders are classified in groups. Stakeholder's engagement is also presented

Table 9: Stakeholders' list

#	Stakeholder	Group	Engagement
1		Research and academia; • Engineering • Technology • Circular economy	Provision of data for research Advance research and innovation Free and transnational access to SmartShip outcomes
2		Policymakers Funding agencies EU and national digital agencies	Access to data Tools for data analysis Use cases and business scenarios for policymakers regarding data-analytical results
3		ICT operators Services operators	Collaboration for research purposes Benefit from the training of data scientists Technical specifications of the SmartShip framework Circular economy principles
4		Businesses • High tech startups • SMEs	Benefit from the training of data scientists Benefits from the training of managers in the implementation circular business models
5		General public: • Civil society • NGOs	Transparency on sensitive data collection Participation: • Non-technical overview of the project • Principal concepts of circular economy
6		Maritime industry End users: • Engineering • Technology • Circular economy	Provision of technical and non-technical business and end user-oriented overview of the project

[1] https://www.trust-itservices.com/

6.1.2 Dissemination strategy

During this period the dissemination strategy and transfer of knowledge has been conducted at the level of intra- and inter-partner cooperation.

Table 10: Dissemination targeting

	Description	Activities
	Content development: • Website • Social media • Dissemination material • Publications	LinkedIn Twitter Booster: logo, flyer, presentation video, interviews, policy brief and capacity building
	Organisation of events: Internal workshops External workshops Training sessions Sponsorship	Circular City Week New York (CCWNY) HUA's first training activity ENPC workshop on CE principles in the maritime industry
	Participation in events: European level International level	CYpBER2020 3rd IEEE international workshop on Smart Circular Economy (SMACE) Veltha Kosovo Sustainable Development Week (KSDW)

6.2 Dissemination activities performed during the Third Year

6.2.1 Participation in events

European Level:

- CYpBER2020: SmartShip supported CYpBER2020, the only specialized CyberSecurity event for Maritime Oil Gas & Energy in the Eastern Mediterranean
- Veltha: 'Loops' First Episode on the Digital Circular Economy. CERC presented the interplay between CE and IoT: Key elements towards circular economy
- Fellow of the week: the activity aims at showcasing research activities of some MSCA fellows
- Kosovo Sustainable Development Week (KSDW): the event aims to promote public dialogue and to seek effective ways to promote sustainable development while advocating for green economic growth. Reserachers from ENPC participated in an online class on the "Legal Framework for Circular Economy in Europe." During the course, SmartShip project was presented
- 3rd IEEE international workshop on Smart circular economy
- Data Week Conference: "Unleashing the potential of ports and maritime logistics via data-driven solutions: Opportunities and Challenges" workshop presenting SmartShip project.
- European Climate Pact: an essential component of the European Green Deal designated to rally people, communities, and organizations to participate in climate action and build a greener Europe

International level:

- Conference of Corporate Social Responsibility (Bolivia): CERC presented its research activities including the SmartShip project
- HANIMOB '21: Proceedings of the 1st ACM SIGSPATIAL International Workshop on Animal Movement Ecology and Human Mobility (November 2021)

6.2.1.1 Organization of Events

Internal:
HUA's first training activity: a hybrid training session was held, gathering people from SmartShip partners aiming to learn about novel methodologies of storing and querying trajectory data and developing micro-services. Read more details in section 6.4.1

ENPC first workshop on CE principles in the maritime industry: A workshop linked to WP3 related to requirements elicitation, use case scenarios and roadmaps for integrated vessel management, more specifically to T2.3 roadmaps for marine vessel management optimization under the principles of circular economy was organized, including the École des Ponts Business School, the Circular Economy Research Center (CERC) and Danaos Shipping Co. Ltd., management staff. The outcomes of the workshop will support the implementation of the circular economy in WP3 SmartShip circular economy based functional architecture design.

External:
Circular Economy Symposium: ENPC participated in a panel and highlighted how CERC is putting circular economy into practice through participating in H2020 projects like SmartShip.
Circular City Week New York (CCWNY): ENPC, more specifically CERC organized an online workshop: Digitalisation and skills in a circular economy where SmartShip was presented

6.2.2 Publications

- ✓ MongoDB Vs PostgresSQL; A Cmparative study on performance aspects, Springer Link
- ✓ A distribiuted framework for extracting maritime traffic patterns, International Journal of Geographical Information Science
- ✓ A Deep Learning Streaming Methodology for Trajectory Classification, ISPRS International Journal of Geo-Information
- ✓ Evaluating the effect of compressing algorithms for trajectory similarity and classification problems, Geoinformatica
- ✓ A Comparison of Trajectory Compression Amgorithms Over AIS Data, IEEE *Xplore*

6.2.3 Conference proceedings

Conference / Workshop	Title	Authors
3rd IEEE international workshop on Smart Circular Economy (SMACE)	Data Driven Fleet Monitoring and Circular Economy	Oikonomou, F., Alhaddad, A., Tserpes, K., Kontopoulos, I., Makris, A., Arampatzi, P., Bonazountas, M., Ruiz-Ocampo, H., Demetriou G., Katusic, V. (2021). Data Driven Fleet Monitoring and Circular Economy. 3rd IEEE International Workshop on Smart Circular Economy (SmaCE), Full paper in proceedings
Proceedings of the 1st ACM SIGSPATIAL International Workshop on Animal Movement Ecology and Human Mobility (HANIMOB '21)	Semi-supervised trajectory classification using convolutional auto-encoders	Antonios Makris, Ioannis Kontopoulos, Evangelos Psomakelis, and Konstantinos Tserpes

6.2.4 Project Website & Social Media

Project Website: SmartShip website is since the beginning, the single-entry point to all the information about the project. The website is updated regularly based on the project's presentations, deliverables, events, publications, news, etc. Content is collected with the support of all partners.

Social Media: considering that the reporting period was impacted by the covid pandemic, online dissemination was prioritized. Target audiences were reached through the project's social media. We actively use Twitter with 138 followers and 113 Tweets and LinkedIn that has 378 followers to share news, events publications, videos etc.

6.3 Exploitation Plan (ALL)

6.3.1 Individual Objectives

The SmartShip partners identified the individual exploitation objectives, which are in alignment with their principal types of activities. Research and industry partners have different types of exploitation objectives. Based on the individual exploitation objectives depicted in Table 11, the identification of possible exploitation synergies between the partners will be analysed.

Table 11: Partner Exploitation Plan

Partners	Exploitation Plan
DANAOS	DANAOS shipping will bring into SmartShip maritime expertise defining challenges that should be addressed in the project with an aim to make a step forward, on top of the current state-of-the-art, towards the digitalization and optimization of maritime operation. DANAOS will interact with research community (represented by SmartShip institutions and universities) and exploit over new ideas and innovative thinking so to jointly re-design and enhance capabilities of existing technology systems dedicated specially to voyage optimization and vessel condition-based monitoring. DANAOS is also aiming to adopt principals of Circular Economy in everyday shipping operation meeting the increasing demand for less pollutant waters and energy efficiency maximization in waterborne transport.
ITML	ITML aims to deliver advancements and enrich its portfolio concerning the data analytics and algorithm tools provided so far by its contribution within the SmartShip consortium. The SmartShip project is a significant opportunity to collaborate with the maritime sector and adapt its platforms and tools according to this specific sector needs (specific type of data, presentation type etc.). ITML also aims to deliver and transfer knowledge regarding technological advancements to the academic partners and built new collaborations and partnerships in the research domain of Europe. Moreover, the outcomes of SmartShip will be exploited by ITML, by reaching better spot in the EU market and environment of big data analytics and machine learning.
EPSILON	EPSILON is flourishing the SmartShip with project Life Cycle Analysis deep knowledge and fundamental Circular Economy understanding. Through the numerous projects undertaken and effectively participated in the Maritime sector for the a/m subjects will deliver a holistic view of all contributing factors towards an optimization of processes. Additionally, partners transfer knowledge in the fields of economics, business, maritime, project management will have significant contributions by EPSILON.
ENPC	ENPC plans to exploit the project results through its Business School and the Circular Economy Research Center (CERC) by offering high-quality executive education, cutting edge technology postgraduate courses, and the opportunity to both doctoral students and researchers (i.e., Ph.D., EDBA) to work on collaborative R&D projects with external stakeholders. ENPC expects exploitation routes through E-MBA, specialized E-MBA, specialized Masters, and E-DBA courses and thesis. The SmartShip outcomes can quickly become the subject of co-innovation projects across the ENPC Business School Paris-Marrakech- Shanghai-Spain innovation network. SmartShip outcomes are likely, to be relevant to specialized consultancy services, executive briefings, and executive training offered by ENPC Ponts Business School. ENPC sees the target audience for the outcomes of this project as a vast swathe of academic partners in France and Europe, as well as further afield in its program partnerships in Asia and Africa. Also, students from undergraduate to postgraduate programs, from various disciplines and schools, and business/industrial partners from multiple sectors in France, Europe. The CERC focus areas include Data Economy (as data – notably big data - is circular by nature). It is expected that the

	project outputs will provide case studies, peer-reviewed publications, creation of specialized workshops, and training, as well as regular blog articles.
BLS	BlueSoft provides a full range of IT services and dedicated, purpose-built software with experience in a wide range of business-oriented solutions, including system integration, cloud and hybrid services, Big Data, and advanced data analysis. The SmartShip project is an excellent opportunity to excel in our capabilities in advanced data analysis, data analysis tools, and to exchange knowledge with academic and commercial partners. It will allow us to provide state of the art solution in the data decision support module and multi-layer optimization tools and technologies. We truly believe that the SmartShip project will create a commercially useful solution to reduce the costs of fleet operation and automated fuel consumption management. We also treat the SmartShip project as an excellent opportunity to build business relationships and transfer know-how and experience from the IoT & circular economy area.
TUBS	TUBS is one of Germany's pioneers in IoT and Embedded system design automation, HW-SW co-design and real-time analysis and optimization for networked systems. TUBS plans to exploit SmartShip project results through its main outlet (being a teaching institution) of offering high quality graduate and postgraduate courses and programs in its areas of expertise, that will be developed based on the effective transfer of research, content, partnerships, and outcomes relative to this project.
HUA	HUA as a non-profit, academic institution intends to be involved in challenging, real-life problems to extend its research interests to new areas and thus advance and proliferate scientific knowledge. The exploitation of the project outcomes from HUA will be in the context of the university's strategic plans, which extend in the following directions: • Education, in which the existing and well-established knowledge and methods combined with the outcomes of the project, will be proliferated among the attendants of the University activities. Due to the advanced nature of this research, this activity will be targeted towards postgraduate as well as continuing education programmes. • Extension of the University's scientific expertise and support of PhD candidates to promote the research. This will enable the organisation to keep the leading position in linking the Greek industry with worldwide evolutions in science and technology. The scientific outcomes of the project will be presented in international conferences and journals, propagating knowledge through the scientific community and stressing the prestige of HUA and the European Community. • HUA is strongly affiliated with and supports the opensource initiatives. As such HUA comprises one of the Centres of Excellence of the Greek OpenSource community (https://ellak.gr). Technology transfer towards the Greek IT industry. HUA maintains very close links with the Greek ICT industry (e.g., organizing the Greek ICT Forum since 2008, working on private research projects, internship programmes), which are used for the promotion of state-of-the-art awareness in technology-oriented organizations of the public and private sectors.

The synergies between different partners will allow to develop a sound exploitation strategy and develop a joint exploitation plan. In that sense, SmartShip partners will organise workshops to support the exploitation activities within the consortium and between relevant stakeholders.

6.3.2 Exploitation Workshops

The participation of relevant stakeholders from the maritime sector is essential to support exploitation and dissemination activities. The SmartShip consortium will organise three exploitation/training workshops to support the development and implementation of the exploitation strategy. Due to Covid 19 and the extension of the project, the updated dates for the exploitation workshops are:

- Exploitation and development plan (M40)
- Identification project results (M48)
- Short-medium term exploitation plan and long-term sustainability (M60)

Exploitation plan development (M40). The first workshop will envisage the development of the joint exploitation strategy. The workshop will allow us to determine the applicability of different circular business models and identify the various dynamic factors towards implementing the SmartShip framework comprising energy efficiency, emissions control, fuel consumption, and CE principles.

Identification project results (M48). The second workshop will valorise the project's key exploitation results, identifying the partners' role regarding the solutions and determining the different strategies for exploitation. Furthermore, applying business modeling tools for circular business models development is a proactive and transversal activity throughout the project.

Short-medium term exploitation plan and long-term sustainability (M60). The third workshop consists of presenting the results of the iterations and aligning the exploitation plan with updated practices for short-medium (6-12 months) beyond the project. The long-term sustainability (>12months after the project) will allow the assessment of the potential circular business plan implementation.

6.4 Training Activities

6.4.1 First Training Session in HUA

On January 12th, 2022, the first training session of the SmartShip project took place at Harokopio University of Athens. Despite the fact that the new covid restrictions did not allow for a full physical meeting, a hybrid training session was held where 21 people from SmartShip partners gathered either virtually or physically to learn about novel methodologies of storing and querying trajectory data and developing micro-services. In the three-part training session, Harokopio University first introduced a novel, and open-source database, called MobilityDB, suitable for storing and querying trajectory data on which SmartShip partners were trained. Then, DANAOS presented its respective tools in the field and their applications in the SmartShip project. Finally, BlueSoft presented Kubernetes, an open-source system for automating deployment, scaling, and management of containerized applications that could prove useful in SmartShip applications.

6.4.2 Training Plan

A basic Gantt chart has been designed regarding activities of T7.3. Specifically, two training sessions have been scheduled so far. Figure 1 depicts training plan for public impact and societal challenges of SmartShip aligned with the exploitation workshops as described in section 4.2.2 of the document; the plan will be continuously updated.

The first training session was held in M34 at the premises of Harokopio University and the second training session will be held in M43 at ENPC premises. The first training session included presentations from HUA, DANAOS and BlueSoft regarding tools that are already used in the project or will be used during the lifespan of the project. The second training session will include presentations of ENPC and DANAOS management staff regarding the concepts of circular economy and the maritime domain, respectively. The third and fourth planned training activities will take place on the premises of the industrial partners.

As far as the workshops are concerned, SmartShip partners have already participated in the SmaCE workshop of the 17th International Conference on Distributed Computing in Sensor Systems (DCOSS), which was held in M28 of the project. There is a plan for at least two exploitation (WSE) sessions, each held in such intervals where the association of technical experiments with business requirements is

facilitated, for example, the development of the Advanced Data Analytics module following Task 4.3. The last workshop/event (WE) will be held at the end of the project to showcase the SmartShip platform.

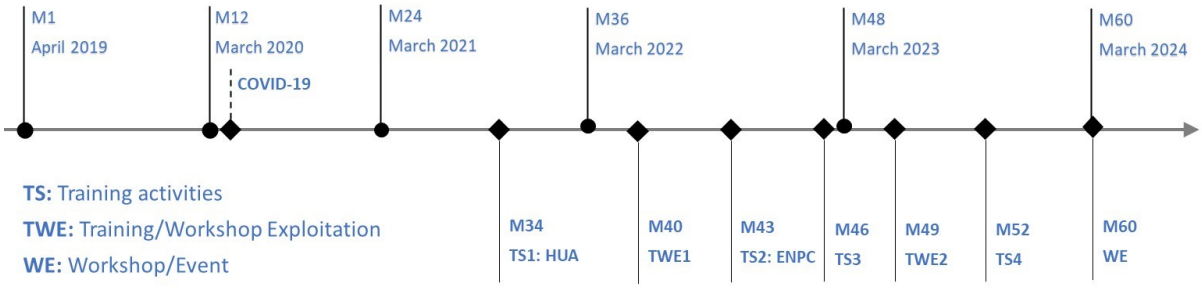

Figure 1: Timeline SmartShip Workshops and training activities

7. Ethical issues

As per Grant Agreement (Article 34.2), SmartShip does not present any of the Ethics Issues listed in the Ethics Issues. All beneficiaries confirm that classified information, materials, or techniques as well as the research results of SmartShip will not be inappropriately disseminated. The consortium will set up a control process of the dissemination and exploitation strategy of the SmartShip results with regards to the above identified issues. This process will define the condition of dissemination (dissemination level for each deliverable). The result of this action will be part of the report at the end of each reporting period.

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The SmartShip project has received funding from the European Union's Horizon 2020 research and Innovation programme under the Marie Skłodowska-Curie grant agreement No 823916

ANNEX I: Secondment Report

A data analytics, decision support and circular economy – based multi-layer optimization platform towards a holistic energy efficiency, fuel consumption and emissions management of vessels

Secondment Report

Name of secondee:	
Hosting Organization:	
Start Date of secondment:	
End date of secondment:	
Secondment ID (SyGMa):	

A. Secondment Report

SECONDED STAFF MEMBER DETAILS	
Full Name:	
Researcher Category:	
Email:	
Tel:	
From:	[org name]
To:	[org name]
Secondment Start – End date:	*The person-months declared in the researcher's declaration (start and end date of the secondment) are consistent with the supporting documents (e.g. travel tickets, accommodation documents, etc...) allowing the auditors to establish the exact duration of the secondments.*
Total PMs:	
WP:	WPX: [name]
Task:	TX.X: [name]

The SmartShip project has received funding from the European Union's Horizon 2020 research and Innovation programme under the Marie Skłodowska-Curie grant agreement No 823916

DESCRIPTION OF WORK OF THE SECONDED STAFF MEMBER	
Relevant Task:	TX.X: [name]
Start – End date of Task	
Short Task Description	
Objectives and purpose of secondment	
Description of the work done during the secondment	
Publications/ Articles/ software prototypes resulting from the secondment	
Research challenges identified that needs further investigations	
Training activity performed	*Describe participation to seminars, courses, schools, etc.*
Networking Activities	*Describe participation to conferences, project meetings, open public events add photos when possible.*

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B. ***Certificate***

SECONDMENT CERTIFICATION

_____
(name / surname)

has successfully completed the secondment from _____ *(Org / country)* to _____ *(Org / country)*
within WP __ and successfully accomplished the reported work during
and

_____ *(start date DD/MM/YEAR)* _____ *(start date DD/MM/YEAR)*

_____ *Secondee*	_____ *Representative of hosting Organization*
_____ *Signature*	_____ *Signature*
_____ *Sending Organization*	_____ *Hosting Organization*

The SmartShip project has received funding from the European Union's Horizon 2020 research and Innovation programme under the Marie Skłodowska-Curie grant agreement No 823916