PROJECT DELIVERABLE REPORT

Introducing advanced ICT
and Mass Evacuation Vessel design
to ship evacuation and rescue systems

D1.6 Scientific Roadmap and Innovation Management Evaluation

A holistic passenger ship evacuation and rescue ecosystem

MG-2-2-2018

Marine Accident Response

Document Information

Grant Agreement Number	814962	Acronym	PALAEMON	
Full Title	A holistic passenger ship evacuation and rescue ecosystem			
Topic	MG-2-2-2018: Marine Accident Response			
Funding scheme	RIA - Research and Innovation action			
Start Date	1st JUNE 2019	Duration		36 months
Project URL	www.palaemonproject.eu			
EU Project Officer	Georgios CHARALAMPOUS			
Project Coordinator	AIRBUS DEFENCE AND SPACE SAS			
Deliverable	D1.6 Scientific Roadmap and Innovation Management Evaluation			
Work Package	WP1 – Project Management			
Date of Delivery	Contractual	M42	Actual	M42
Nature	R - Report	Dissemination Level		PU-PUBLIC
Lead Beneficiary	JOAFG			
Responsible Author	Georg Aumayr	Email	Georg.aumayr@johanniter.at	
		Phone	+43 676 83 112 814	
Reviewer(s):				
Keywords	Scientific roadmap, innovation management			

Revision History

Version	Date	Responsible	Description/Remarks/Reason for changes
0.1	2023/01/10	JOAFG	Report write-up
0.2	2023/01/15	JOAFG	Inclusion of partners' contributions
0.3	2023/01/30	JOAFG/ATOS	Internal Review
1.0	2023/03/05		Review and Release

Contents

Abbreviations

MEV	Mass Evacuation Vessel
TRL	Technology Readiness Level
PO	Project Officer
TRL	Technology Readiness Level
SAR	Search and Rescue

1   Summary

This deliverable is focused on the scientific roadmap and further paths for exploitation of the core results and the reporting of innovations that resulted during the project and allow also additional exploitation next to the core elements together with a scientific roadmap for the further production of scientific output. Most of the content is elaborated in several deliverables of the project. Therefore, this report is a short summary and can be used as an executive summary of the main innovations of the project with links to the reports for the elaborated descriptions. This deliverable aims at the provision of a short notice and perspective on exploitation and impact of the PALAEMON project.

As core elements have been defined:

- Sustainable construction material for ship structures
- Smart Monitoring System
- Smart Evacuation System
- Training methods for Ship Crew and passengers
- Design concepts for novel Mass Evacuation Vessels under respect of medical interventions and diversity aspects

The aim of this report is to provide a roadmap for the project consortium as orientation where the exploitation paths will lead to and gather all strings of exploitation for the next years after the project.

Together with the deliverables D9.4 and D9.5 this allows a full perspective on the commercialisation.

Input sources: D9.2; D.9.5/D9.6

Output to: Consortium, PO

2   Introduction

The scientific roadmap is fed by the dissemination deliverables and reports and feedback from partners for the upcoming publications.

It provides a short overview from management perspective and supports the IPR management in terms of public results and open science data.

The five core elements are built up for the roadmap in a common way to allow a better overview. Oriented at the model of Technology Readiness Levels (TRL) and a time scale, it should become obvious how the consortium will progress after the project and support industrialisation and take up of results to ensure the sustainability of results of PALAEMON.

The project reached in the core elements different TRLs.

For the upcoming developments, the time scale is set for a 5-year perspective.

By nature, the more to the future the projection is reaching, the more inaccurate the picture gets. The realistic perspective is 1,5 years. After this, the roadmap will be facing divergence from the aim of PALAEMON and reach out further to different exploitation routes and combine with other results from developments. After 5 years, it is estimated by the authors that the blur becomes so heavy that it is not rational anymore for making further projections.

3   Scientific roadmap

Dissemination activities and scientific publications are summarized in D9.2 Dissemination activities report (3).

Following the official PALAEMON publications, the project was presented at one Conference and one workshop as well as to one event of maritime stakeholders. Additionally, there were 2 non-scientific publications about the project.

The focus was especially on the Social Media posts (100) and on updates on the website (920)

Further to this, a lot of small-scale presentations and actions for dissemination have been done. E.g. at the Security Festival (Sicherheitsfest) in Vienna, JOAFG presented the project to an audience of roughly 800 people directly over 2 days.

Nevertheless, a short list of accepted publications is available here.

Geyer, C., Aumayr, G., Prinzellner, Y., Ragab, A., Panagiotidis, P., Giannakis, K., ... & Liapis, A. (2021, November). Disabilities in Evacuation for Cruise Ships-Leisure Lab Methodology to Support an Algorithm-driven Evacuation Prediction Model. In *2021 IEEE International Conference on Computing (ICOCO)* (pp. 259-264). IEEE.

Rainer, K., Leidwein, A., Nemenz, P., Hoffmann, M., Neubauer, G., & Aumayr, G. (2020). Interoperability and crisis management in pandemic outbreak scenarios an overview on different case studies of the austrian approach to tackle the SARS-CoV-2 spread and adherent management challenges. *28th Interdisciplinary Information Management Talks: Digitalized Economy, Society and Information Management, IDIMT 2020*, 153-164.

Ventikos, N. P., Themelis, N., Louzis, K., Koimtzoglou, A., Michelis, A., Koimtzoglou, M., & Ragab, A. (2021). Evaluating risk during evacuation of large passenger ships: A smart risk assessment platform for decision support. *Trends in Maritime Technology and Engineering Volume 2*, 283-294.

Vidal Pinto, R. A. (2022). Labeling and evaluation of a new dataset for human action recognition in large vessels.

Koimtzoglou, A., Themelis, N., Ventikos, N. P., Louzis, K., Koimtzoglou, M., Giannakis, K., ... & Ksystra, K. (2022). Assessing the risk during mustering in large passenger vessels: A digital tool for real time decision support. In *Sustainable Development and Innovations in Marine Technologies* (pp. 269-276). CRC Press.

Panagiotidis, P., Giannakis, K., Angelopoulos, N., & Liapis, A. (2021). Shipping Accidents Dataset: Data-Driven Directions for Assessing Accident's Impact and Improving Safety Onboard. *Data*, *6*(12), 129.

3.1   Achieved scientific results

During the evaluation phase for requirements, JOAFG investigated a new method for testing complex environments and their impact on gait speed. By this, they created a new approach "Leisure Lab". This approache uses the different attractions of a Leisure park/Tivoli and compares the special attractions to real life risks and situations. By this, recreative industry becomes a laboratory for science and allows standardized testing. In this first case of using this method, JOAFG used a geriatric simulation suite in a mobility park area of the Viennese Prater. The different moving grounds and floors were compared to situations of a rolling ship and the evacuation situation. With the geriatric suite and a test condition without the suite, gait speed of disabled passengers could be simulated and compared to healthy subjects. This data will be made available as open access data for further analysis.

JOAFG and UAEGEAN used eye tracking as support for the pilot actions to take time measurement of reception speed and reception to action speed. With a sample of 20 students from NTUA naval architects' students, pilots were supported and measurements taken.

3.2   Upcoming scientific reports and papers

UAEGEAN and NTUA envisaged publications about the pilot outcomes.

JOAFG will further explore the Leisure Lab approach.

4   Innovation radar

ATOS supported the consortium in developing business plans and commercialization routes for their outcomes of the project. There is a list of 22 assets provided that show the developments and outstanding developments of the PALAEMON project. This is reported in D9.5. As a perspective for a roadmap, a time of next 3 years was taken into consideration.
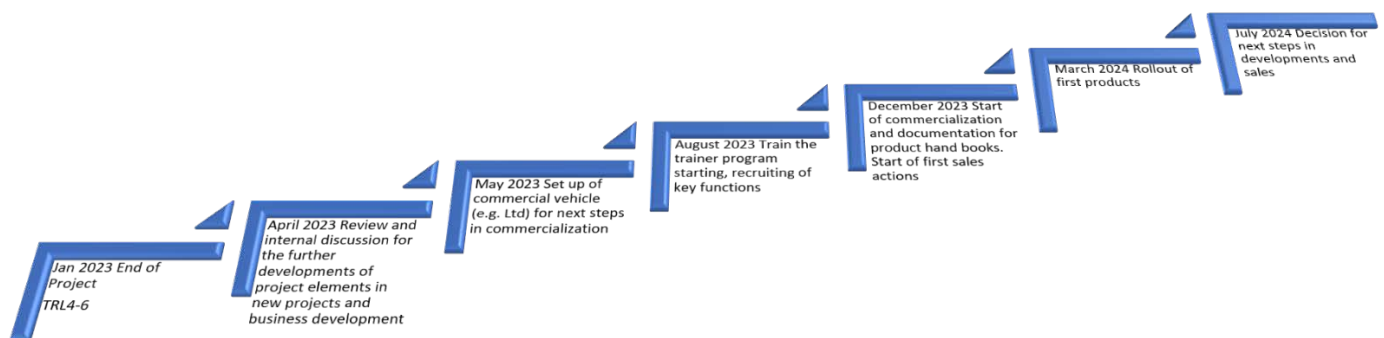

Figure 1Roadmap to commercialization

For the near future, the rout to commercialization is planned for the next 12 months (see Figure 1) by starting an agreement on the next steps and the legal form how to proceed. Within the first 6 months after the project, all material and content should be gathered for the commercialization and the final product manuals are to be provided. Until autumn, the personal recruitment should be done and trained for the product line. Sales would start until end of the first year and start after 12 months with the operative business and product line.

The initial investments for this, are described in D9.6. At the end of the PALAEMON project, the market is probed if certain elements are already requested by the market and pre-sales activities are initiated.

To support this pre-sales actions, the innovation radar is described within table 1 in an innovation matrix.

Innovations can be classified by the perimeter towards the project. This allows once to identify near chances for commercialization and areas for an added value for developments of the project.

Within the close perimeter of the project, the classical stakeholders of the maritime industry are well known and described in D9.2 and D9.6.

But especially for the outer perimeter of the project, the identified areas of education, training of special staff, use of multisensory platforms and integrated surveillance systems find a fruitful landscape of opportunities. Within table 1 an overview of perimeter and related development

is enlisted to allow a first categorization. Within the cells of the matrix, the target group is named with a short description of potential use. All innovation go BEYOND the purpose of PALAEMON and shall point towards the added value and further commercialization routes.

Innovation description	Near perimeter	Middle perimeter	Far perimeter
Indoor localization to identify passengers location and finding missing people	Cruise industry: Counting customer frequency on decks and leisure areas.	First Responder: Observation of field missions and own staff during crisis situation or festivals with a rapid deployable infrastructure	Retirement homes: Observation and alarming for seniors with dementia to prevent unobserved leaving of secured areas
Drones for inspection of damage	Ship industry/Warft: Drones could be used to support inspections. Also automated drone flights for regular maintance checks could be used.	Construction industry: general inspections can be done with drone flights and support maintenance	SAR elements: During Search and Rescue Operations, drones could be used to assess onsite damaged structures and support in faster clearance and surveillance
Recycled fiber material as construction material for MEV	Ship industry/Warf: lighter hull, cheaper material for construction	Cargo industry: lighter and sustainable containers could be built.	Automotive Industry: lighter and more ecological chassis can be developed
VR ship simulator	Ship industry: training for new crew can be done ashore at a training facility to reduce downtime of crew aboard	First Responder Training: VR can be used to train complex situations without the need of dedicated training grounds	General Industry: Training for new technologies and evaluation of potential procurements ahead of installation.
Learning Management System	Ship industry: training for new crew can be done ashore at a training facility to reduce downtime of crew aboard	General Education facilities: Already in use. Innovation in this field is the content.	General Education and Training: LMS allow multi media content and Mixed Reality Learning experiences to increase immersion and training outcome.

PaMEAS – Integration of multimodal sensors	General industry: already available for maintenance support.	Leisure Industry/Stadium: Large leisure structures like Football stadiums can benefit from the multimodal sensor arrays to increase safety and improve evacuation planning	Health Industry: Multimodal sensor arrays can support in the moniroting of health status and development. With AI algorithm, changes in the behaviour of the owner can be detected and related to health issues.
Post incident analysis	General industry: Black box systems	Insurances: to support parametric insurance models and fasten the mitigation after an incident	Disaster Response: Post incident analysis can support in identifying potential damages to human and infrastructure to allow a better recovery planning after major incidents.

Table 1 Innovation Matrix

Concerning the different TRL of the single assets, D9.5 Tab27 is providing the overview of the TRL in relation to the single elements. From perspective of system components in terms of functionality, the assets are clustered in 5 main discussion areas.

Within the project, 5 main clusters have been defined by the consortium as main innovation and development roads:

1. Sustainable Construction Material for Ship Structures
2. Smart Monitoring System and – Decision Support System with Real Time Data Monitoring
3. Smart Evacuation System - Evacuation Support Platform Based on Real Time Data from Passengers Location
4. Training Methods for Ship Crew and Passengers
5. Design Concept for Novel Mass Evacuation Vessels under Respect of Medical Interventions and Diversity Aspects

As these elements are described throughout the project and final deliverables (D9.2, D9.5, D9.6) a just short wrap up of this shall be given here.

4.1   Asset Cluster Matrix

<p align="center">PALAEMON Asset Matrix</p>

		1	2	3	4	5	6	7	8
		Smart Bracelets	Smart Cameras	Ship Health Monitoring	VHF Data Exchange Sys	PaMEAS	Data Fusion Bus	Safety Management System	Evacuation Coordinator
1	Sustainable Construction Material								
2	Smart Monitoring System	x	x	x	x	x	x	x	
3	Smart Evacuation System	x	x		x	x	x		x
4	Training Methods								
5	Design Concept of Novell MEVs								

		9	10	11	12	13	14	15	16
		Weather Forecast Toolkit	Smart Safety System	Ship Stability Toolkit	Voyage Report Generator	Decision Support System	Incident Management Module (PIMM)	Smart Risk Assessment Platform	AR Glasses
1	Sustainable Construction Material								
2	Smart Monitoring System	x		x	x		x	x	
3	Smart Evacuation System		x			x			x
4	Training Methods								x
5	Design Concept of Novell MEVs								

		17	18	19	20	21	22
		Academy eLearning	Academy VR	MEV	Inflatables	Training Platform	MEV-I Interior Design
1	Sustainable Construction Material			x	x		x
2	Smart Monitoring System						
3	Smart Evacuation System		x				x
4	Training Methods	x	x			x	
5	Design Concept of Novell MEVs			x	x		x

4.2   Sustainable Construction Material for Ship Structures

Astander developed a new material for the construction of the MEV prototype that allows using recycled material with similar material durability as steel. This is a gamechanger in industry and allows lighter constructions. Astander has a patent on this material technology and will use it in further developments and ships.

4.3   Smart Monitoring System

A usability test done by JOAFG, JU and OELS in Vienna tested the PaMEAs elements of PALAEMON. By this, it was indicated that the information structure of the current version of the dashboard on the bridge does allow some decision support for the Master on the bridge. But the information structure is not accorded to the chain of commands. An adjusted role management would be needed to condense the needed information to a format or chunk that is supporting the decision process. At this moment, there is sufficient data available. But actually, this mass of data is too much to allow a fast data oriented planning of actions and starting of evacuation procedures.

In the VR tests of the bridge, clear statements about the usability showed that there is still some work to be done, before it could be tested with practitioners in a context-oriented exercise.

Nevertheless, the integration of multiple sensors from the ship on one dashboard is a positive development.

4.4   Smart Evacuation System

The passenger App of PALAEMON was tested in Athens and Piraeus with students from NTUA under the guidance of UAEGEAN and support by JOAFG for eye tracking. This allowed a seamlessly measurement of actions and reception speed of subjects during the evacuation messaging process. At the time of writing the deliverable, the data analysis is still pending. But first impressions from the pilot indicate a positive outcome.

4.5   Training Methods for Ship Crew and Passengers

The training methods for ship crew and passengers was realized via a Learning Management System (moodle) and a VR training system, which was bought from M2D and cooperative developed by JOAFG and M2D for the purpose of PALAEMON. This allowed an efficient setup and progress for the training environment. Together with partners from OELS and JU, the final content was integrated and testing of the MEV have been made possible even without a real prototype of the MEV-2.

This approach showed some strengths for future technological developments for click mock ups and functional testing with the Wizard of Oz methodology.

By this PALAEMON supported already other EU projects like METICOS, where these findings were realized for a new technology test at automated border gates.

This is reported in D9.6.

4.6 Design Concept for Novel Mass Evacuation Vessels under Respect of Medical Interventions and Diversity Aspects

From a general design of the novel MEV, a Mixed reality Mock Up was developed and tested by JOAFG and their Emergency Medical Technicians for best practices of patient transport and evacuation as well as for medical support concepts for MEVs. This is reported in D4.8 and D4.9.

5 Evaluation of Innovation Management

The innovation of PALAEMONs sub-products has reached beyond expectations. Most of the technologies have been further developed and added value to the components have been documented in the pilot actions.

Most of the main developments reached TRL between 5 and 7.

In D9.5 of PALAEMON, a list of 21 assets has been summarized to show all elements of PALAEMON that have been developed or further developed. The full innovation eco system consists of the

- Smart Evacuation
- Ship Monitoring
- Global monitoring
- Post-incident Analysis
- PALAEMON Academy

This ecosystem will support the exploitation roadmap described in D9.5.

5.1 Case study JOAFG for an impact on one partner:

From the core expertise of the consortium, the field of action was widened to more areas and beyond the maritime area of action. Didactic concepts and learning management systems have been initiated. This LMS based on moodle was actually used by JOAFG during the COVID-19 crisis with the knowledge of PALAEMON to set up another course to train Emergency Medical Technicians (EMT) in the theory-chapters and allow to have classes for their professional trainings online. This allowed the Ambulance Service in Innsbruck, Tyrol in Austria even under COVID restrictions to educate EMTs.

Another aspect was the discussion on inclusive language and learning material during the project runtime. This initiated the development of Gender Equality Plans in some partners. Additionally, JOAFG used this momentum to start a gender sensitive communication directive to adjust to modern needs.

6   Conclusions

PALAEMON's exploitation strategy shows for multiple project partners development areas for a sustainable take up of results from the projects outcome in different areas of action. Within the next years, further research activities will be based on the projects results and provide improvements to industries in the maritime area and beyond.

The cooperation of within the PALAEMON project showed how many different disciplines could cooperate – even with a pandemic situation disrupting the usual work processes – on a common goal and provide results beyond the expected outreach.

New methodologies for testing vessels and life boats and health related impacts on evacuation speed showed the importance of the actions done within PALAEMON. This will support the efficiency and quality of future developments and decrease costs in safety developments.

The innovation management provided in the project runtime, allowed sufficient degrees of freedom to reach beyond the project boundaries and influence other industry sectors. During the project runtime, findings from PALAEMON are already supporting other projects and boosting developments.

Even with some negative experiences during the project runtime, the consortium recovered from critical events (e.g. pandemic outbreak) and worked until the very last minute for the project. And are dedicated to work further on.

Finally, we want to thank the PALAEMON consortium for three exciting years of innovative approaches, challenges that have been addressed together as a team and for the open minds in several disciplines and expertise's to reach a common goal.

May the seas lie smooth before you. May a gentle breeze forever fill your sails. May sunshine warm your face, and kindness warm your soul.