Ship Lifecycle Software Solutions (SHIPLYS) – an overview of the project, its first phase of development and challenges

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Abstract

SHIPLYS is a three-year project that started in September 2016 with funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 690770. The project is in response to needs of SME naval architects, shipbuilders and ship-owners, who, in order to survive in the world market, need to: a) improve their capability to reduce the time and costs of design and production, b) reliably produce better ship concepts through rapid virtual prototyping, and c) meet the increasing requirements for LCCA (Life Cycle Cost Analysis), environmental assessments, risk assessments and end-of-life considerations as differentiators. SHIPLYS aims to build on existing experience in the shipping sector, and transfer experience from the development of life cycle modeling and rapid virtual prototyping in other industry sectors. This paper presents an overview of the project, a summary of the initial stage of development of the project and the challenges posed. The paper will interest a variety of industry stakeholders including designers at shipyards, ship owners, classification bodies, researchers and technology providers to the shipping sector.

1. Background

This project is driven by requirements of small and medium enterprise (SME) shipyards that need to come up with reliable cost estimates in the limited time, which can be as little as a few weeks, they have to respond to tenders for new building or retro-fitting jobs. This involves, to start with, the use of early ship design tools for new building tenders, or some form of basic representation of the structure to be repaired or retrofitted. Such tools, albeit providing approximate solutions are required to assess the scale and scope of work involved without going into detailed assessments that typically require more data often unavailable at the stage, or additional expenses and time.

Increasingly, such solutions also need to be customized to operators' requirements to find optimum performance from the perspectives of life cycle costs (LCC), environmental impact and risk management. There are a number of different types of stakeholder organizations that have an interest in the solutions being proposed. These include: ship owners/ operators, shipyards, classification bodies, service providers that provide inspection and maintenance related functions, and, lobbyists such as environmentalists. SHIPLYS enables the concerns of various stake-holders to be taken account of at the very initial stages of ship design or retrofitting. Thus, the ambition in the project is not just to help shipyards in making rapid and reliable estimates in response to tenders, but also to enable them to add value to the services that they provide by giving them the ability to assess and provide costing for different options with corresponding LCC, environmental impact and risk profiles.

2. Introduction

The explicit objective of the SHIPLYS project is to develop software solutions for SME shipyards to support them in responding to new building or ship retrofitting tenders. The software will enable them to make quick cost estimates based on the scale and scope of such work that is also optimized on LCC, environmental impact and risk management criteria.

This project will develop functionality for ship-yards to arrive at reliable early (bid-stage) cost estimates and to have the capability of assessing the viability of alternative options based on certain criteria, thereby increasing their efficiency and adding value to the services they currently offer.

The software functionalities being developed are rapid design and production simulation tools that are integrated with SHIPLYS 'life cycle tools' (LCT). SHIPLYS LCT are software Applications that enable LCC analyses (LCCA), environmental impact estimates, risk assessments, and multi criteria decision analyses (MCDA). The project does not seek to re-invent the wheel, so where certain functionalities are already provided by existing software packages, the project will adapt these to SHIPLYS requirement and integrate them using the SHIPLYS software platform. Where required, specific software applications will be developed to meet the objectives of the project.

SHIPLYS software will be available to buy or licence after completion of the project and shall be supported on a commercial basis.

Figure 1 indicates a type of output in terms of LCC that can be obtained by integrating design and production simulation tools and LCT.

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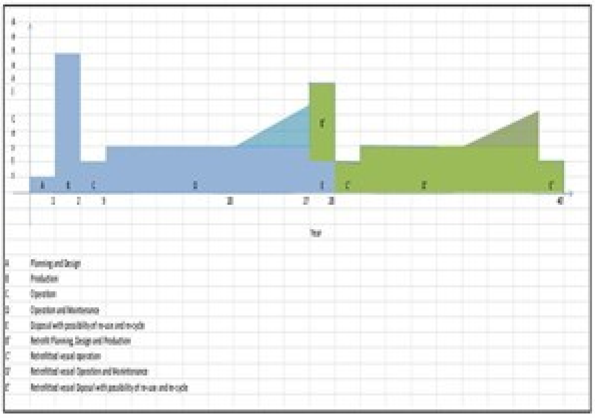

Figure 1: Life cycle costs (indicative, not to scale)

MCDA will enable end-user specified criteria to be used in the assessment of aspects such as operational costs, disposal costs, risk tolerance etc. (1) describes an MCDA framework that includes the pro-vision of conducting sensitivity analyses and uncertainty in input data to be considered.

Another key aspect of SHIPLYS solutions is providing shipyards with the ability to exchange data between existing software using ISO 10303 protocols (2) and a REST based platform as depicted in figure 2. ISO 10303 is a standard for computer-interpretable representation and exchange of product manufacturing information. This standard is also known as STEP (Standard for the Exchange of Product model data) and can represent 3D objects in Computer-aided design (CAD) and corresponding product model information. REST (Representational state transfer) web services are a way of providing interoperability between computer systems.

Figure 2 shows different Applications communicating with the SHIPLYS platform using appropriate 'glue' code. For example, Application 2 will need a glue code to be integrated to the platform;

addition-ally, if Application 2 needs Application 1, then the glue code will need to have the code to ask for such inputs via the platform. The glue code can evolve. So, if Application 2 needs Application 3 in the future, additional code can be added to the original glue code with minimum/ no change to the platform code. Thus, the SHIPLYS software has some flexibility in terms of connectivity with future or existing Applications not considered at present.

[Zoom]

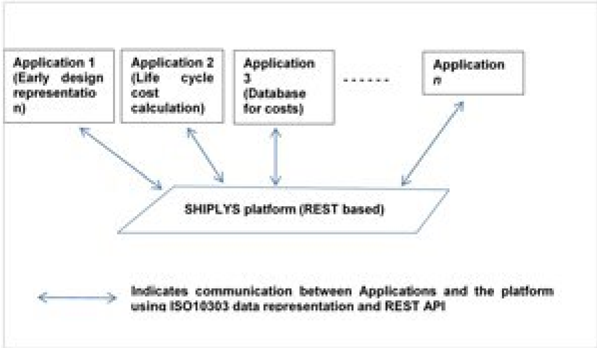

Figure 2: SHIPLYS platform

The development of SHIPLYS is guided by some end-user cases. These are called 'Scenarios' that indicate the types of problems for which the SHIPLYS project aspires to develop solutions. Whilst these Scenarios direct the development of the project, we envisage that the final SHIPLYS software will have generic functionality for it to be used in other situations.

3. In-built Mechanisms Within The Project Directing Development Towards SME Shipyard Priorities

3.1 SHIPLYS Stakeholders' Advisory Committee

SHIPLYS Stakeholders' Advisory Committee (SAC) is an external industrial advisory group comprising professionals from major stakeholders who are interested in the objectives and results of the project. Engagement with them is helping the project learn and address the needs of the industrial community. The SAC is also viewed as a mechanism for dissemination of SHIPLYS results. The SAC arrangement is also benefitting stakeholders: issues raised by them are potentially being addressed in the project and they are also invited to software training sessions towards the end of the project.

The SAC has periodic physical/ on-line meetings coinciding with some of the project progress meetings. The first physical meeting is planned under the auspices of the IMAM 2017 conference (3). The SAC members are given advance overview of the current status of the project so that they can prepare themselves for the meetings. The project has a travel and accommodation budget for the SAC members to participate in such meetings. A list of SAC members can be seen at project website at (4).

3.2 Formal approach to match end-users' requirements and priorities with solutions developed

A structured approach based on Quality Function Deployment (QFD) was developed during the initial stages of the project. This approach defines software functional characteristics in response to specific end-users' needs and their priorities. In the development of the approach, cognizance was taken of relevant work in other industry sectors, as well as the ship-ping sector such as (5).

Key output from this work is a matrix set-up showing what the end-users need along one axis, and proposed software features on the other, with a color coded scheme showing the potential extent to which the features match such needs (Figure 3 shows the matrix from SHIPLYS Deliverable D2.2). This matrix is being consulted continually and will form a reference point for comparison with the final software towards the end of the project. More details regarding this approach can be obtained from (6).

[Zoom]

Main need / requirement category	Category definition	Need/requirements sub-categories	Importance rating	Extensive database	Life cycle cost assessment tool	LC environmental assessment tool	Life cycle risk assessment tool	Multi-criteria decision support tool	Ship operation profile tool	Ship configuration tool	Rapid prototyping tools	Production analysis and planning tools
Reliability	Being free of doubts and uncertainties	Being confident in calculations and data	9	M	M	M	M	M	M	M	M	M
		Being confident in the software technical performance	8		M	M	M	M	M	M	M	M
		Supporting ship design in accordance with rules and regulations	8	M		S	S		M		W	
		Documenting and reporting the design process	7	M			M				M	
Convenience	Doing work with little or no effort, stress or limits	Having an intuitive and clear user interface	8		M	M	M	M	M	M	M	M
		Requiring no special IT skills	6	M	M	M	M	M	M	M	M	M
		Having simple installation process	6		M	M	M	M	M	M	M	M
Competence	Making informed design decisions, performing the work well, maintaining high level of task / work quality	Estimating energy consumptions, environmental impacts and risk	7	M	S	S	S	M	S		S	W
		Making ship behavior predictions	7	M			M	S	M	M	M	
		Being able to compare different ship designs and identify optimal solutions	8	S	M	M	M	M	M	M	M	M
		Estimating design work activities and volumes	7	M	M					M	M	M
		Providing input for production process	7	S	S	M	M	M	S	S	M	S
Efficiency	Doing the work fast, reducing time	Having flexibility in ship design modification	8	M							M	M
		Making quick estimations	8	M	S	S	S	S	S	S	S	S
		Automating of design processes	6	M						M		
		Enabling a variety of information handling and processing options	7	M	S	S	S	S	S	S	S	S
Profit	Increasing income	Gaining value for money	7		S							
		Software resulting in monetary savings	7		S			M		W		S
			Score	315	371	306	348	308	325	312	361	332
			Rating	9	2	12	4	11	8	10	3	6

Figure 3: Quality Function Deployment process (strong re-lationship = red; medium = yellow; weak = green)

3.3 Steering obtained from SME Shipyards present within the SHIPLYS Consortium

There are three SME shipyards in the SHIPLYS Consortium that provide steering to the developments in the project. They are: Astilleros De Santander SA (ATD), Spain; Varna Maritime, Bulgaria (VARNA); and, Ferguson Marine (FERG), United Kingdom.

Taking cognizance of their day-to-day business commitments, these shipyards are paired with 'technology providers' who work closely with them in providing inputs to the project. In this regard ATD, VARNA and FERG have Fundacion Centro Tecnologico Soermar (SOERMAR), Instituto Superior Tecnico (IST), and the University of Strathclyde (USTRATH) respectively, providing support to them. The other technology/ service providers in the Consortium - Atlantec Enterprise Solutions (AES), Alveus l.l.c. (As2CON), BMT Group Limited (BMT), Lloyd's Register EMEA IPS (LR), National Technical University of Athens (NTUA), and TWI Limited (TWI) – bring their own expertise to the project, and together with those paired with ship-yards are responsible for developmental activities in the project.

To gain first-hand information regarding the issues faced by shipyards, workshops are held at different shipyards that also provide opportunities for dissemination of project activities. To gain relevant information from state-of-the-art ongoing research and avail of any synergy, cluster meetings are being held with the two other projects involving ship operators and different shipyards that have, like SHIPLYS, received funding from the European Un-ion's Horizon 2020 research and innovation programme. These projects are: HOLISHIP aimed at holistic optimization of ship design and operation for life cycle (7) and LINCOLN aimed at using innovative design methodologies and tools for the development of three types of completely new vessels concepts through dynamic simulation model testing in the maritime sector (8). These projects have some common interests with SHIPLYS - such as the life cycle cost assessments in HOLISHIP and simulation modelling in LINCOLN. However, unlike SHIPLYS, these projects involve more detailed design and corresponding detailed data.

By far, the most significant direction provided to the project is through the Scenarios provided by the shipyards present in the SHIPLYS Consortium. These Scenarios, that form the starting point of the SHIPLYS project, present issues that the shipyards face and would like the project to address in terms of life cycle software solutions.

Unlike projects that develop methodologies and implement these in case studies towards the end of the project, the SHIPLYS Consortium decided at the proposal stage itself to start with certain specific case studies - called Scenarios – representing issues faced by the shipyards in SHIPLYS.

Whilst the focus of SHIPLYS software developmental activities is on the end-user defined and market-driven Scenarios, it is envisaged that the solutions developed will have generic aspects that will find applications in a variety of situations.

The next few sections provide more information on the Scenarios. Each Scenario has ‘Scenario Owners’, who are the shipyard and the corresponding technology provider.

4. Scenario 1: Optimisation Of A Novel Hybrid Propulsion System Used In A Short-route Ferry

The hybrid propulsion system being considered combines internal combustion engines and battery cells. The optimization here is to determine the most suitable combination of propulsion (i.e. the proportion of propulsion directly from combustion and that from battery), using a life cycle approach covering LCC, risk assessments and environmental impacts.

The approach will cover operation and maintenance, scrapping and recycling stages. Potentially, the implications of optimizing the propulsion system on the design and production of the short route ferry will also be considered using the generic functionality of the suite of software created.

In addition to optimizing the design of the hybrid system, an evaluation of three different propulsion systems: the hybrid system that distributes loads to generators and batteries based on specific route undertaken, the diesel –mechanical (D-M) system that propels the ship directly, and the diesel – electric system (D-E) that converts fuel into electricity that drives motors to propel the ship (figure 4). Such an evaluation will be from the perspective of ship life cycle costs, environmental impact and risk assessment.

Work done in the FP7 projects Eco-REFITEC (9), MAINLINE (10) and MOSAIC (11) , and the European Platform for life cycle assessment (12) will be considered in the development of applications within the Scenario. The ECO-REFITEC project aimed to assist shipyards and ship operators to per-form cost effective refitting of existing fleet through technological developments and new tools helping to benchmark their performance and improve the retro-fit processes and products and assessing the environmental and life cycle cost impact. In MAINLINE a life cycle assessment tool was developed to provide decision support in the integrity management of assets (such as bridges) from a life cycle perspective. MOSAIC investigated the use of special steels and composite materials for lighter, more eco-friendly merchant ships; the project involved looking at different options from a life cycle perspective. These projects had a common theme of evaluating options from a life cycle perspective, therefore allowing for knowledge gained to be transferred to

SHIPLYS. Moreover, the project will avail of benefits from the European platform on life cycle assessment (12) in this and other Scenarios.

More information regarding this Scenario is available in (13).

[Zoom]

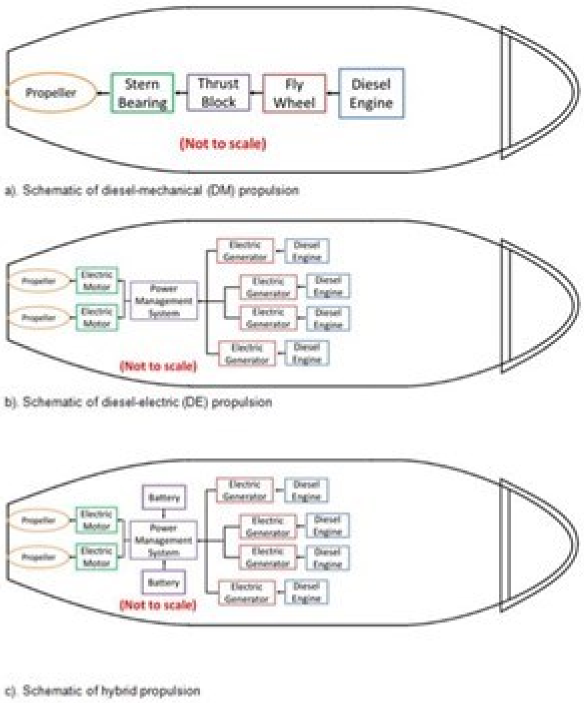

Figure 4: Schematics of a D-M, D-E and a hybrid system

5. Scenario 2: Development Of Conceptual Ship Design With Inputs From Risk-based Life Cycle Assessments

This Scenario, owned by VARNA and IST, is aimed at developing software capability to generate conceptual ship design with inputs from risk based life cycle assessments. The scenario is organized in three consecutive tasks: Task 1 on conceptual ship design, Task 2 on risk-based structural assessment and Task 3 on risk-based maintenance. Task 4 is focused on fast hull geometry prototyping and Task 5 is related to production assessment. Tasks 4 and 5 will be carried out in parallel with Task 1 (figure 5).

The approach being developed for this Scenario will be first applied to a Multi-Purpose-Ship, with VARNA involved in the development and testing of the approach. The shipyard has experience with this ship type and the information that they have will be used to calibrate the developed applications.

VARNA expect that the development of this Scenario will enable SMEs shipyards to make more reliable estimates, given the client requirements in the early stages of inquiry and the shipyard`s existing production capacity. Concurrently, they expect benefits from the provision to study the implications of risk-based inputs to conventional early design and the evaluation of options in terms of their LCC effectiveness and the environmental impact. It is expected that this Scenario and the software developed can be adapted to other ship types apart from Multi-Purpose-Ship, particularly where novel aspects are being introduced often necessitating a risk-based approach, and to other shipyards in addition to VARNA.

More information regarding this Scenario is available in (14).

[Zoom]

Figure 5: Conceptual Ship Design accounting for Risk-based Life Cycle Assessment

6. Scenario 3: Development Of Software To Support Early Planning And Costing Of Ship Retrofitting Accounting For Life Cycle Costs And Risk Assessments

This Scenario, owned by ATD and SOERMAR, is aimed at developing software to support early (bid-stage) planning and costing of ship retrofitting, taking account of LCC and risk management of processes involved. Risk management in the context of this Scenario includes hazard management and project management risks such as scheduling conflicts and the impact of delays. The ship retrofit process is a reengineering process of the vessel which in many cases can involve fundamental changes in the architecture, functionality or operation of the vessel, but the nature of repair and retrofitting projects differs substantially from long term new building projects.

The ship retrofit planning process is focused on production systems for retrofitting/repair activities where optimal solutions for reducing costs, risks, safety and environmental impacts in a shipyard carrying out such work require rapid simulations.

For this purpose, a ship retrofitting recently carried out in ATD (related to the installation of Scrubbers in an existing ship ROPAX), is proposed as a case study. Figure 6 shows a ship without Scrubbers and then after retrofitting of Scrubbers shown in the dotted circle.

More information regarding this Scenario is available from (15).

[Zoom]

Figure 6: M/V Normandie before and after retroffiting (©: BRITTANY FERRIES)

7. Scenarios Taken Together

The SHIPLYS Scenarios represent specific issues, solutions to which are being developed in the project. Although the underlying theme of the project is providing support to SME shipyards from the perspective of LCC, environmental impacts and risk assessments, as summarized in the previous sections, and from the referred papers that provide more in-formation on the Scenarios, it is clear that they have significant unique aspects, and a ‘one-size-fits-all’ approach is not appropriate. Whilst SHIPLYS soft-ware solutions are being developed bearing in mind specific problems faced by specific SME shipyards, the software may be used for a wider range of applications and in other shipyards. It is for this reason that the project is undertaking a program of extensive interaction with shipyards and other stakeholders at every stage in the project.

8. Shiplys Simulation, LCT Modules and Software Integration

Figure 7 gives an overview of the SHIPLYS suite of software. Our starting point is existing software/ approaches used in the initial stages of design or retrofitting such as FORAN (16) and in-house tools at shipyards or existing at universities for academic use. Using bid-stage data, the project aims to conduct rapid design and production simulations and support decision makers arrive at optimal solutions from LCC, environmental and risk assessment perspectives using SHIPLYS 'Life Cycle Tools' (LCT).

[Zoom]

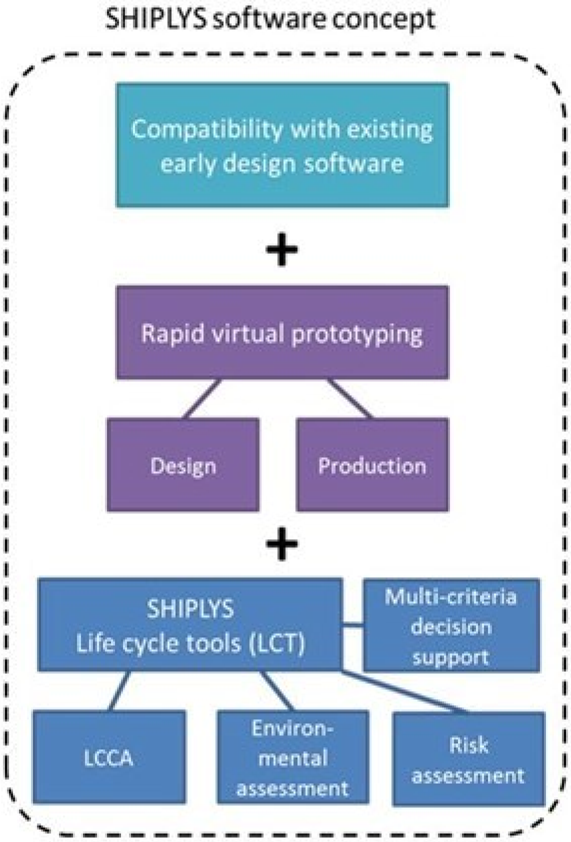

Figure 7: SHIPLYS software concept

In the development of SHIPYS software, cognizance will be taken of existing early design tools (Applications) being used by the shipyards. A plat-form using Representational State Transfer (REST) interface (shown in figure 2), enabling interoperability between computer systems, will provide data sharing and management functionality, with various Applications (developed within the project or from external sources) accessing the platform. The data structures within the platform will be based on ISO 10303 Application protocols, as adapted to the requirements of the project. More information on these aspects is available from (17).

Figure 8 is a block diagram showing how the SHIPLYS Work Packages are connected. WP1 on 'Ethics requirements' and WP10 on 'Project management' (not show in the figure) are led by TWI. WP 2 is aimed at confirming and defining the Scenarios in more detail than at the proposal stage; WP3 is aimed at specifying requirements for integration of simulation tools and LCT; WP4 is aimed at assessing the quality of data required for use in the various SHIPLYS modules, and developing databases; WP 5 is aimed at developing the LCT modules including MCDA; WP6 is aimed at implementing simulation generators capability; WP7 is aimed at the integration of simulation and LCT modules; WP8 is aimed at testing, demonstrating, verifying and developing good practice guidelines; and, WP 9 is aimed at the important activities of software training, developing exploitation plan and dissemination of project results to wider audience.

[Zoom]

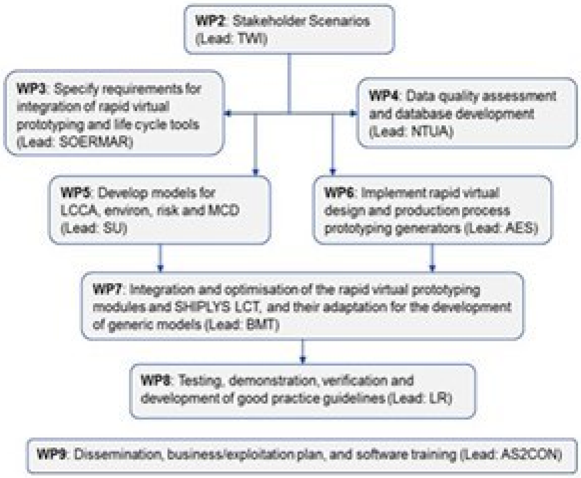

Figure 8: SHIPLYS Work Packages

9. Challenges

SHIPLYS poses a number of challenges. One key challenge is ensuring compatibility of applications developed within SHIPLYS with the availability of data at bid-stage. Such data is typically obtained from tender documents, in-house data at shipyards or other stakeholders (for example, classification bodies) collected from experience and external data libraries (for example, data regarding emissions). Such data may not be in a template readily usable in the applications. To address this challenge, all Scenarios start with data that is realistically available with shipyards present in the SHIPLYS Consortium. The management of such data and its potential sharing taking account of confidentiality requirements is facilitated by standard protocols. (18) provides more detail on the challenges being faced regarding the quality and the availability of data in the early design phases.

Another challenge is to find the right balance between specific functionality and generic functionality. Although the underpinning theme of the project is life cycle management, environmental impact assessments and risk assessments, the SHIPLYS Scenarios that are being used for the development of functionality within the project have sufficient unique aspects requiring individual attention. For ex-ample, new building processes (Scenario 2) differ from retrofitting processes (Scenario 3). Recognizing the risk of losing focus, the strategy being implemented in the project is to develop solutions for specific issues highlighted by the shipyards via the Scenarios, bearing in mind generic applications of SHIPLYS solutions to similar problems faced by a wider set of shipyards. In addition, in the SHIPLYS Consortium there is a multi-disciplinary team that brings a wealth of experience in both specific and general application of life cycle approaches.

It is recognized that Applications that are integrated or that can be integrated on the SHIPLYS platform will be owned by those who hold the back-ground or foreground IP (Intellectual Property) and are subject to the terms and conditions applicable. The project has a dedicated on-going task to address this matter for both stages: during the project and after the project is completed. It is envisaged that after the project’s completion, the SHIPLYS platform will be maintained, and users of the platform and the Applications will need to pay for access on a commercial basis.

The project aims to develop software solutions for SME shipyards. Thus, it is important that the external applications that need to be ‘called’ are affordable to SME end-users. However, at the same time such applications need to have some degree of credibility in industry so as to provide end-users with confidence in the results. It is for this reason, the project partners continually ask for relevant inputs from the SME shipyards and the Classification Body, LR, present in the Consortium. Additionally, there is frequent interaction with other stakeholders through the SHIPLYS SAC, workshops and seminars.

10. Acknowledgement

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Note: The authors, their respective organizations and the European Commission assume no responsibility and shall not be liable to any person for any loss, damage or expense caused by reliance on the information or advice in this document or howsoever provided.

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