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Ship Lifecycle Software Solutions (SHIPLYS)

Project Deliverable Report

D9.5 Final Exploitation and Business Plan

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EXECUTIVE SUMMARY

The EU funded SHIPLYS project, under the Horizon 2020 research and innovation program, has been created to provide innovative ship design and decision tools, to be used by European SMEs in the ship industry. The integrated rapid prototyping modelling tools along with Life Cycle Cost Analysis (LCCA), environmental assessments, risk assessments and end-of-life considerations aim to offer a complete software platform tool that will improve the competitiveness of the European SME shipyards by reducing the time and cost involved in ship design and production and of the design offices during the bidding process.

As part of the project's implementation plan in WP9, the development of a final business and exploitation plan will investigate the potential for the commercialisation of the SHIPLYS outcomes at the end of the 3 years.

This deliverable will present an overview of the final business plan and exploitation activities developed for the tools created in the project, the shipbuilding market trends, the competition in the software market as well as an estimation of the economic and financial gains from the commercialisation of the SHIPLYS suite for all of the beneficiaries.

The final business plan will present different options for the business exploitation of the SHIPLYS tools and a working market strategy by the suggestions and expectations of the different partners of the project. As part of the market strategy, the targeted market will be presented in economic terms and different price strategy scenarios will be analysed along with sale and promotional activities for an effective market strategy plan. Additionally, the critical inputs for the development of a competitive ship design tool and successful market entry will be presented.

Finally, several financial tools and economic ratios will be used to evaluate the investment and forecast the economic results for the exploitation of the SHIPLYS platform, based on best practice assumptions and market information available during the development of this deliverable.

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TABLE OF ABBREVIATIONS

3D	Three Dimensional
AEC	Architecture, Engineering, And Construction
API	Application Programming Interface
bn	Billions
CAD	Computer-Aided Designing
CAE	Computer-Aided Engineering
CAGR	Compound Annual Growth Rate
CAM	Computer-Aided Manufacturing
CGT	Compensated Gross Tonnage
DWT	Deadweight Tonne
EDA	Electronic Design Automation
EU	European Union
FEA	Finite Element Analysis
FEM	Finite Element Method
FTI	Fast Track to Innovation
GT	Gross Tonnage
GUI	Graphical User Interface
HCI	Human–Computer Interaction
IP	Intellectual Property
IRR	Internal Rate of Return
LCA	Life Cycle Assessment
LCC	Life Cycle Cost
LCCA	Life Cycle Cost Assessment
LCT	Life Cycle Tool
mDWT	Million Deadweight Tonne
MPV	Multi Purpose Vessel
MRP	Manufacturing Resource Planning
NACE	Nomenclature statistique des Activités économiques dans la Communauté Européenne

NPV	Net Present Value
O&M	Operation & Maintenance
ONCCV	Other Non-Cargo Carrying Vessels
Rev.	Revised
SHIPLYS	Ship Lifecycle Software Solutions (EU project)
SME	Small and Medium-sized Enterprises
SMEI	Small and Medium-sized Enterprises Instrument
USD	United States Dollars

1 Introduction

Ship Lifecycle Software Solutions (SHIPLYS) is a three-year research project initiated in September 2016, and its main objective is to develop a software tool that will include rapid virtual prototyping processes of the early ship design together with support decision tools to derive to the optimal designs. To this purpose different methodologies for life-cycle cost analysis (LCCA), environmental assessment, risk assessment and end-of-life considerations have been developed.

The project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 690770. The maximum grant amount for the development period is estimated at 6.144.150,00 €, and it reimburses 70% - 100% of the action's eligible costs. The SHIPLYS final product is planned to be delivered by September 2019.

The SHIPLYS project has been led by a consortium of maritime industry members composed of three (3) shipyard clients, three (3) universities, one (1) naval architecture company, two (2) supply chain solution suppliers, two (2) industrial R&D institutions and one (1) standards and validation body, aiming to develop a comprehensive software suite, that will give benefit to SMEs around Europe by reducing shipbuilding time and production cost, while improving energy efficiency. The consortium expertise has contributed to the development of a competitive and high-performance product, and while reaching completion of the project, the business and exploitation strategic decisions of the project's outcomes need to be addressed among the partners.

This deliverable provides the guidelines for the introduction of the developed product to the ship design software tools market with the development of a sufficient business plan, taking into account the analysis of the specific market as well as the development of an exploitation and marketing strategy for the commercialisation of the SHIPLYS tool. The market analysis will include the establishment of targets, the identification of the market segments and the analysis of the investment environment.

2 SHIPLYS software tool

2.1 Presentation of the SHIPLYS tool/ Innovations

Changing the process of ship design by using an advanced Computer Aided Design (CAD) tool from the early stages of the ship offers significant advantages in terms of quality and costs. The most remarkable benefits are the data integrity, the avoidance of long design periods and cost increases due to errors, re-work and inconsistencies. On the other hand, the main challenges to be addressed refer to integration at all stages and disciplines by the use of a single CAD tool. The selected tool must be useful at all stages, from the quick definition of the 3D model to the transfer of modelling information to the analysis and calculation tools.

The SHIPLYS project is developed in response to the needs of SME naval architects, shipbuilders and ship-owners for improving their capabilities to design innovative and high-tech vessels while reducing the time of these procedures and the costs of design and production.

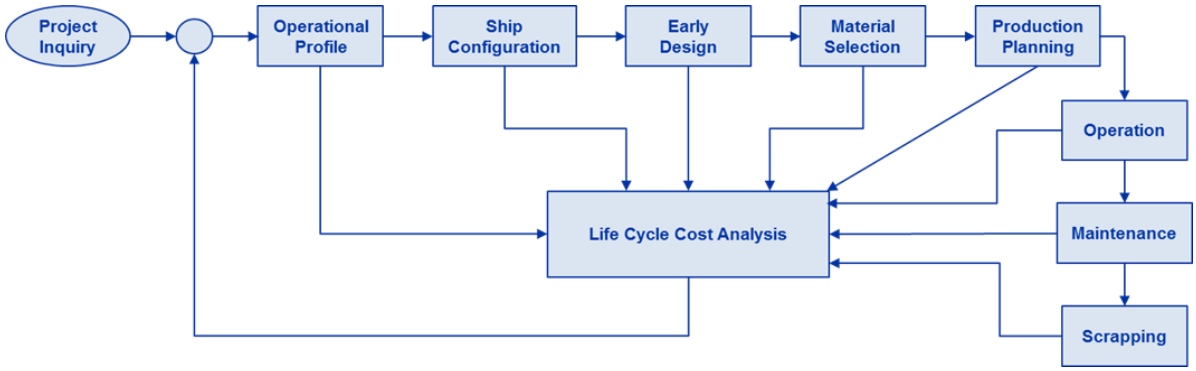


Figure 1: SHIPLYS tool overview

The calculation and modelling to achieve the functionalities required to produce ship designs to satisfy the market trends are difficult and time-consuming, especially for SMEs without a significant overhead of trained staff and tools. The tools developed under the project are dealing with the challenges of the modern shipbuilding industry by integrating data between previously incompatible tools and formats for different design stages, from conceptual hull design to virtual prototyping simulation models.

The central objective of the SHIPLYS project is to develop a software platform of integrated software solutions for SME shipyards and design offices to support them in the bidding stage. The platform will enable them to make quick cost estimates based on the scope of work required to fulfil the design requirements and to provide them with additional decision support criteria based on life-cycle cost estimations, environmental and risk assessments.

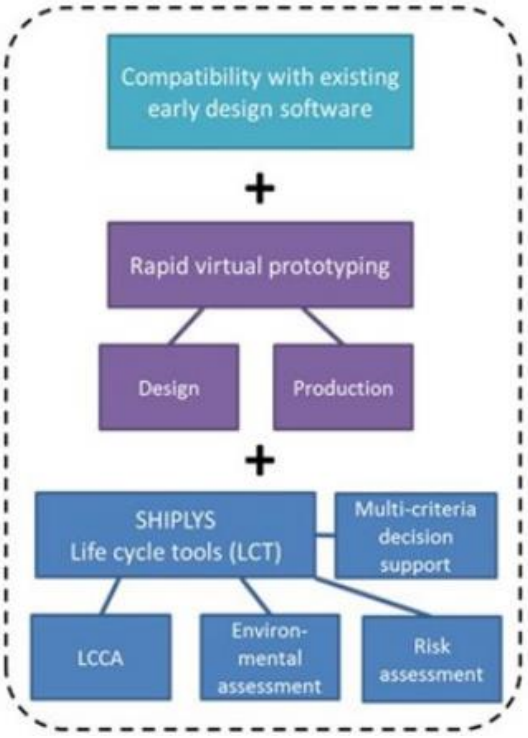


Figure 2: SHIPLYS software concept

The developed platform endorses lifecycle modelling techniques, to meet the increasing requirements for LCCA (Life Cycle Cost Analysis), environmental assessments, risk assessments and end-of-life considerations to support reliable decision-making. The Multi-Criteria Decision Analyses (MCDA) enables end-user specified criteria to be used in the assessment of aspects such as operational costs, disposal costs, risk tolerance etc. The described MCDA framework includes the provision of conducting sensitivity analyses and uncertainty in input data to be considered.

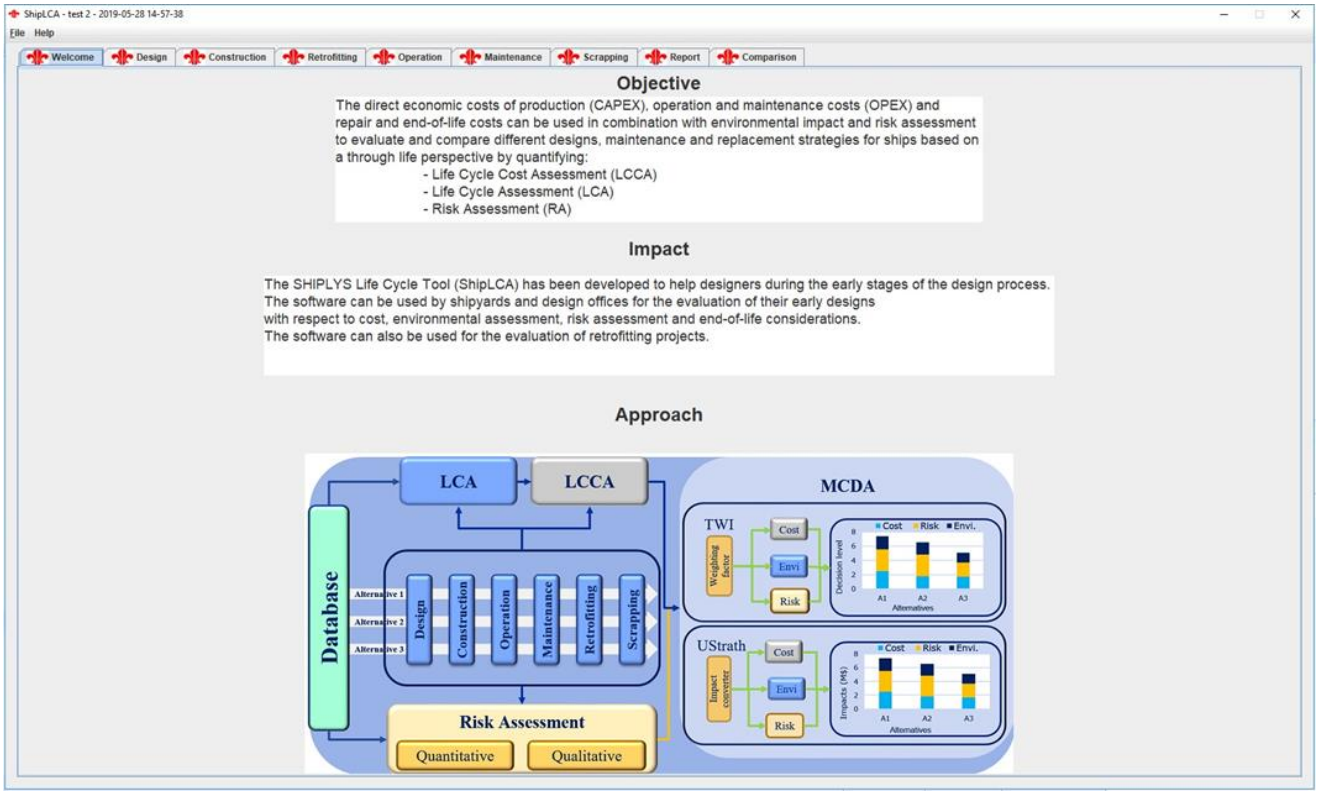


Figure 3: ShipLCA welcome page

The SHIPLYS platform is not only an integrated design platform to facilitate ship design process within the context of LCCA but will also be able to deliver modern ship design solutions (3D modelling), perform retrofitting techniques to existing ship and provide estimations on life-cycle costs (LCC) and the environmental footprint of the ship's construction, operation, maintenance and dismantling. Additionally, it will be able to optimise the ship design procedures, evaluate the process and compare different approaches used by European SMEs in the shipping industry.

The full suite of tools within SHIPLYS platform comprises of:

- Graphical User Interface (GUI)
- Requirement Identification Tool (RIT)
- ConceptSHIP
- RSET
- Rules Calc
- CAFE
- SEASAFE
- PPT
- ShipLCA
- Risk SHIP

Some of them already exists on the market and some are developed through a project. One advantage of the SHIPLYS platform is modularity where the user can choose only modules / tools that are required.

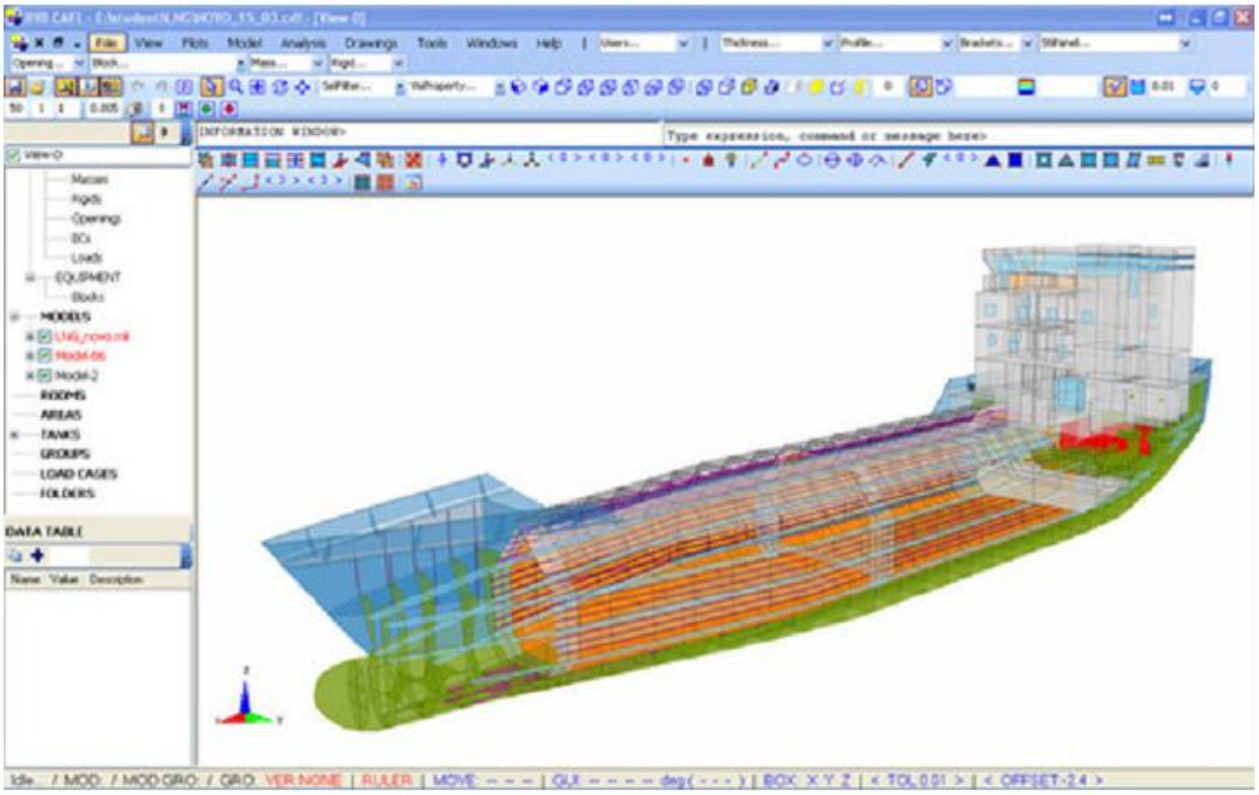


Figure 4: CAFE Structural 3D modelling

The Graphical User Interface (GUI) of the SHIPLYS platform allows the user to track progress through the design process and to verify if the tender requirements are met, but also to identify and resolve possible design issues if any.

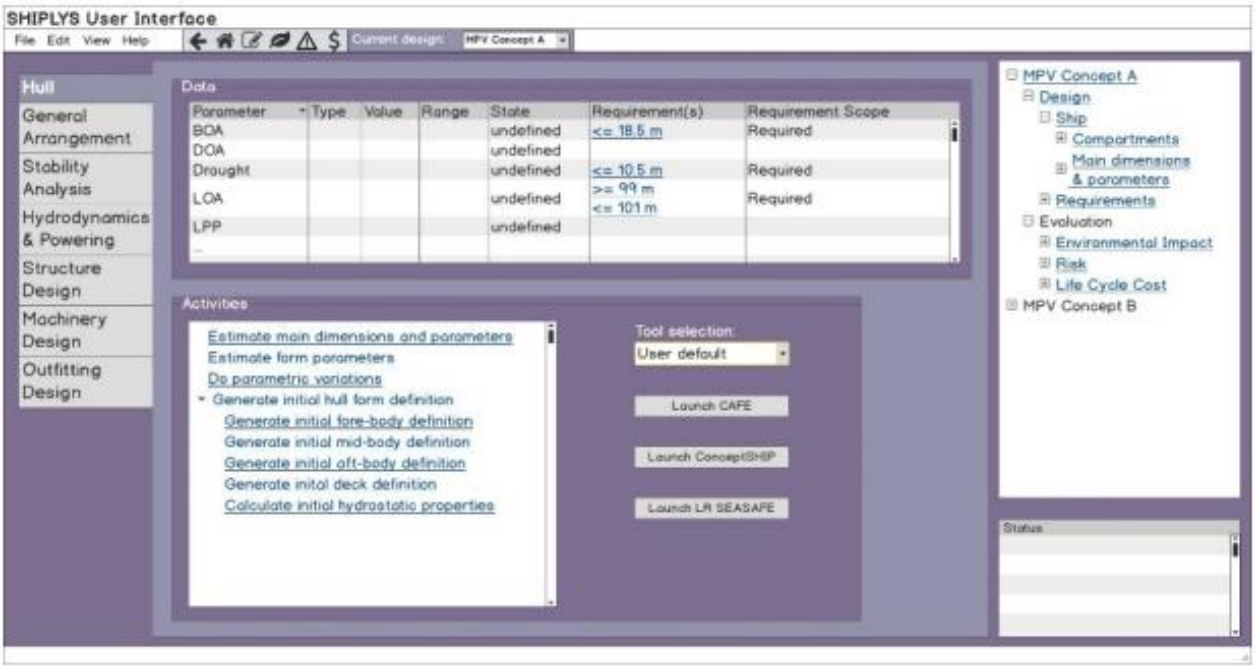


Figure 5: Graphical user interface (GUI) of the SHIPLYS platform

The GUI environment offers the option to start a new project, start a risk analysis, an environmental analysis or LCCA. It is worth noting that the selection and the sequence of the design tools in SHIPLYS platform are flexible and that for different projects, a user can choose different tools for the same design activity. More details can be found in the deliverables D6.1, D6.2 and D6.3 [23] of the SHIPLYS project where all tools are described in detail.

The main innovations provided by the developed platform are:

- Integration of different tools and operations.
- Integration of data and ship designs at different stages.
- A comprehensive Life Cycle Cost Analysis.
- Environmental assessment of the developed projects.
- Risk assessment of the developed designs.
- Multi-criteria decision tool for optimal ship design.
- Integration of designs for retrofitting procedures.

As part of the work during the implementation of the SHIPLYS project, in order to offer improved design tools and paradigms and to allow new designs and processes to minimise the total costs of production, operation, refits and scrappage, thus meeting the new sets of legislative and client-based requirements, existing prototyping models and approaches in shipbuilding and other industry sectors have been studied.

Following in the footsteps of the automotive, aerospace and construction industries, the project aimed to transfer the lessons learnt to provide an integrated framework to generate cost-effective simulations based on reliable data and to provide data format improvements to allow the persistence and re-use of information through the process. To do so, the consortium identified transferable know-how from existing prototyping models and life cycle approaches in shipping / shipbuilding and other industry sectors, adopted the experience from the development of industry modelling coherence schemes and product life cycle management approaches and used them to produce new techniques for quick, reliable multi-disciplinary modelling capability for the marine industry.

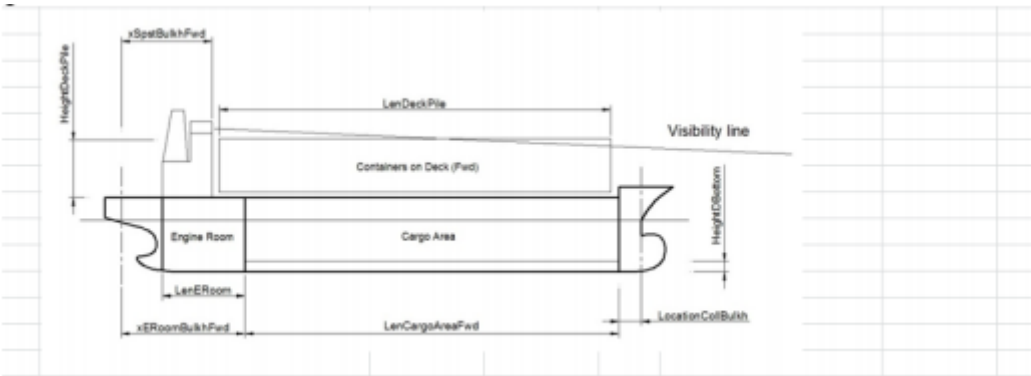
The knowledge achieved has been shared among stakeholders of the shipping industry, including shipyards, ship owners, R&D developers and academics, for cutting-edge practices and assets' performance for minimal total costs over the useful economic life. Life Cycle Cost Analysis (LCCA), environmental and risk assessments, product and process lifecycle management (PLM) and Virtual Product tools developed from previous national and EU level projects for integration into a comprehensive, customised and single package simulation and analysis tool, have been studied to achieve the goals of the SHIPLYS project.

Furthermore, the project has selected and developed appropriate scenarios with stakeholders, particularly SME shipyards, for detailed assessment within the project. Such assessment is to develop virtual modelling tools to reduce time spent during early ship design particularly in SME shipyards and to enable optimal design with life-cycle cost assessment (LCCA), environmental assessment and risk assessment.

2.2 Product R&D and testing

The rapid virtual prototyping modules, the lifecycle analysis, the environmental and risk assessment tools are all integrated into the SHIPLYS platform to create an innovative and holistic tool available to SMEs across Europe who are looking to improve their competitiveness and keep up with shipbuilding industry developments.

The optimisation of the developed tools and the successful integration into the platform require testing of the different modules, verification of the results and the development of good practice guidelines to be used by the end-users. These guidelines include the requirements for integration of the rapid virtual prototyping, life cycle and risk estimations.



Longitudinal Main Zones		
Length of Aft Peak	5.50	[m]
Length of Engine Room	15.36	[m]
Length of Cargo Area	83.64	[m]
Location of collision bulkhead	0.05	[-]
Length of Fore Peak	5.50	[m]
Cross-section Dimensions		
Min. Height D.Bottom	0.94	[m]
Height of Double Bottom	1.20	[m]
Width of Wing Tank	1.20	[m]
Height of Hatch Coaming	1.60	[m]
Containers Layout on Deck		
Number Vert. TEU above Hatch	4	[-]

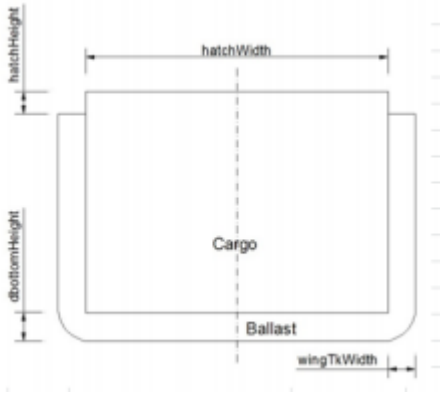


Figure 6: Evaluation of main ship characteristics using ConceptSHIP

Further to the development of the models for LCCA, environmental assessment, risk assessment and multi-criteria decision making, the project has developed data quality assessment methodologies to evaluate the database developed within the project.

The consortium and more specifically, the software developers of the project have been consistent with the policy for software development provided to the SHIPLYS project participants to ensure conformance to copyright requirements. The policy is mainly focused on software developed for or provided to the SHIPLYS product(s) by each SHIPLYS project participant; in particular SHIPLYS partner code and application programming interface (API) code.

Additionally, the project has adopted the ISO 10303 Standard to be implemented to the project's activities. ISO 10303 is an International Standard (also known as STEP) which was started around 1984 as an effort to develop a suite of data exchange standards and tooling methods for the computer-interpretable representation of product information and the exchange of product data [1]. The objective is to provide a standard reference capable of describing products throughout their life cycle. This mechanism is suitable not only for data exchange, but also as a basis for implementing and sharing product databases, and as the basis for archiving. The standard is organized into an extensive collection of parts, grouped by type of content. The specific ISO standard is relevant to the work in the project twofold:

1. The activity models in the Standard could be used as a starting point for the definition of the detailed process flow model;
2. The use of a common data modelling language as well as a standard catalogue and parts library for general use in digital applications.

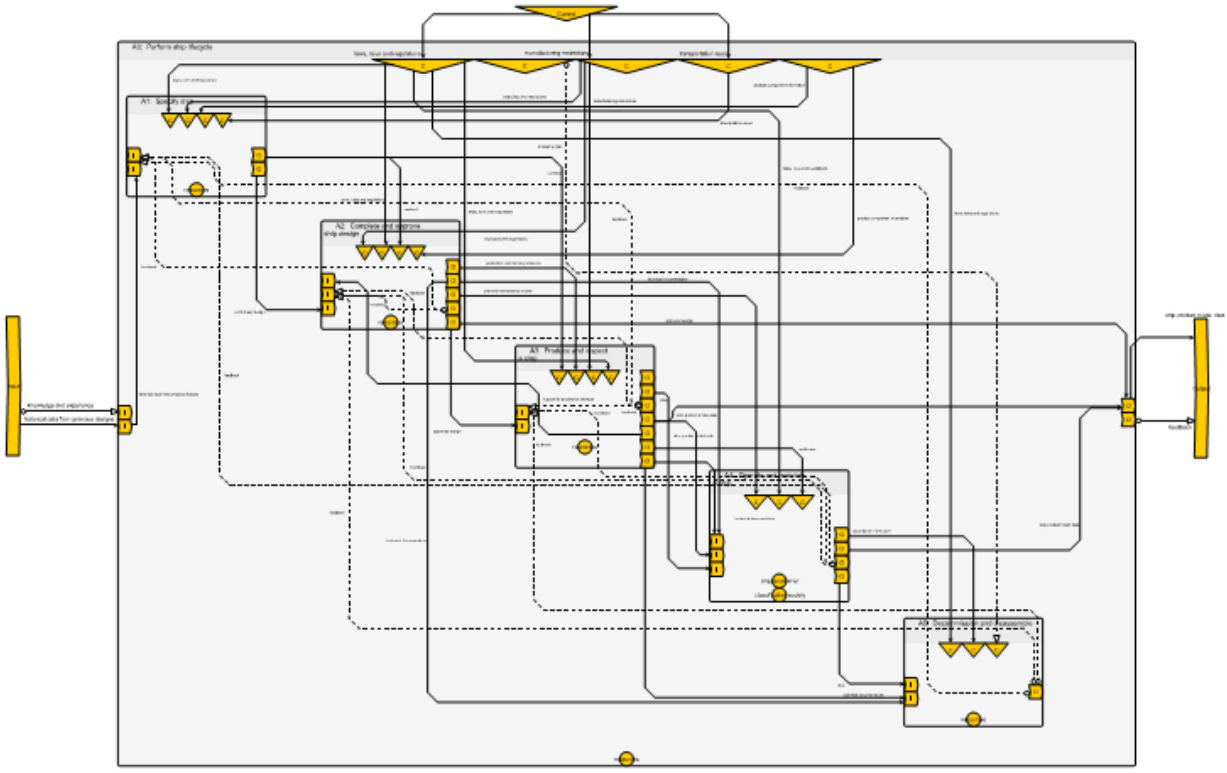


Figure 7: ISO 10303 AAM yEd process flow model

Further to the activity models described by the ISO 10303 Standard, several additional activities and sub-activities have been created in the context of the SHIPLYS project, supplementing and improving the existing ISO model.

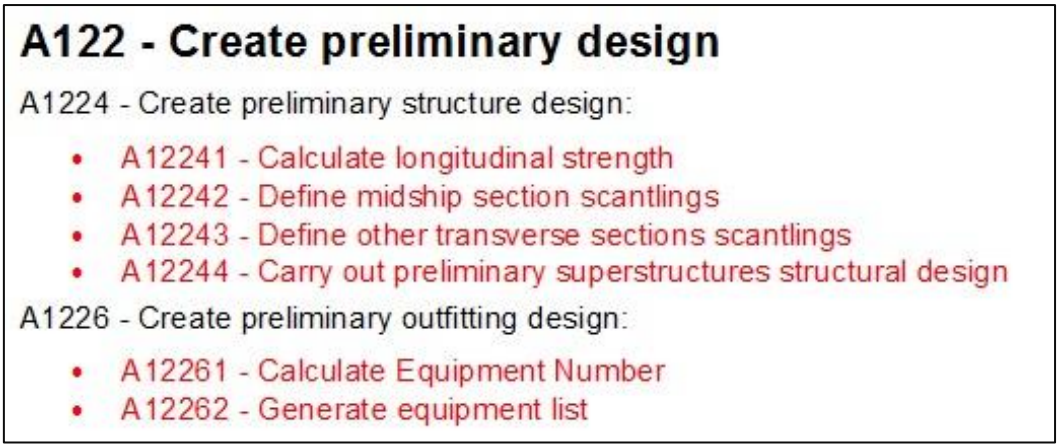


Figure 8: e.g. Activity A122 – Extension of sub-activities (in red)

To test and validate the functionalities and the tools created within the project, three shipbuilding scenarios have been developed by the SHIPLYS partners.

The scenarios that qualified through the evaluation process are presented briefly below[1]:

- Scenario 1: Hybrid propulsion of a short route ferry [Ferguson Marine (FERG) and University of Strathclyde (USTRATH)]

This scenario aims to optimise the design of a short-route ferry (domestic voyages) using a novel hybrid propulsion system, which combines internal combustion engines and battery cells. A hybrid propulsion system is Diesel-Electric (D-E) as opposed to the conventional Diesel-Mechanical (D-M). The analysis for this scenario covers the whole life cycle of the ferry, including design and production, operation and maintenance and scrapping and recycling stages. In each stage, cost analysis, environmental impacts and risk assessments are considered.

- Scenario 2: Conceptual ship design of an MPV vessel accounting for risk-based LCA [Varna Maritime (VARNA), Instituto Superior Técnico (IST) and Atlantec Enterprise Solutions (AES)]

A conceptual design of a new Multi-Purpose Vessel (MPV) is carried out within the environment of an SME shipyard, accounting for the shipyard's constraints in terms of engineering specification, construction and operational costs and using technologies embedded in existing software applications and in the SHIPLYS software tool. The procedure involves ship design and optimisation in terms of naval architecture (main ship dimensions) and marine engineering systems design employing a risk-based LCA, including risk-based structural design, operation and maintenance (O&M) optimisation, greener design for environmental impact, retrofitting options and end-of-life decommissioning. In parallel to the conceptual design, fast hull prototyping and production assessment is carried out approaching the shift of an SME shipyard from a main repair functionality to a new-construction functionality, with a capacity to build new ships.

- Scenario 3: Retrofit or repair works [Astilleros de Santander (ATD), SOERMAR and Atlantec Enterprise Solutions (AES)]

This scenario has been developed in the scope to support a repair shipyard during the bid-stage to optimise retrofitting design and production and to arrive at realistic costs. The scenario includes the calculation of Life Cycle Cost (LCC), the performance of Life Cycle Assessment (LCA) and Risk Assessment (RA), quantifying the overall cost and impact of the retrofit/repair works (e.g. scrubbers and/or ballast treatment installation) during the project implementation.

Production optimisation includes transforming to a new vessel type portfolio, which for example requires the use of thin sheet materials, which in turn need new or updated methods for cutting and welding. An

[1] The scenarios are presented thoroughly in the deliverable D2.1: Selected scenarios and the rationale for such selection

additional consideration is that where the shipyard moves to a modular construction concept, where as much as possible standard assemblies of the ship are manufactured.

The project members have developed a training strategy to be applied for familiarising end-users of the SHIPLYS platform with all functions and tools that are in scope for the typical early design scenarios selected for this project along with a plan for the implementation of the training strategy. The training requirements have been determined by investigations and consultations with the ship design and shipyard end-users and both the engineering and the administrative perspective have been taken into consideration. Apart from looking at the specific aspects related to the functions of the SHIPLYS platform, each of the design tools included in the demo scenarios have been considered.

2.3 Impact

The SHIPLYS project has built on the existing experience of its partners in the shipbuilding and software sector, to develop a complete platform for ship designers and small shipyards by transferring practices from the development of life cycle modelling and rapid virtual prototyping in other industry sectors.

Key tasks in the project included:

- The development of innovative ship design processes.
- The development of LCCA, environmental and risk assessment software modules for fast and cost-effective evaluation of alternatives.
- The integration of such modules with rapid early design and production simulation tools.
- The development of multi-criterion decision analysis techniques to support decision making across the short/ long term, based on explicit user-defined decision criteria.
- The ability to exchange data between software tools via the SHIPLYS software platform.

The above tools and platform capabilities will offer to SMEs around Europe the possibility to enhance their operational capacity, adopt new innovative designs and effectively face the increasing competition in the shipbuilding industry. The developed system will increase the competitiveness of SME design offices and shipyards by enabling them to generate cost-efficient concepts in a short time, thus increasing their competitiveness in the market.

The European SMEs will have a significant tool to support their decision making on the proposed ship designs by improving safety and sustainability from a life cycle perspective. The end-users will be able to select from several software modules, based on their requirements, to support their project under development and they will also be able to choose different tools for different stages of their design projects.

Software developers across Europe will have the opportunity to offer their products or specific modules on ship design and ship construction, to a broader customer base, improving their performance. Finally, the SHIPLYS integration tools and services will enable additional third parties to join the platform and eventually lead to a broader design marketplace - an attracting feature for end-users.

3 Market Updates

3.1 Shipbuilding market trend

One of the first steps in the development of a product is the analysis of the market in which the developed tools will be launched. Continuous monitoring of the market will provide additional information for the developing process. Additionally, the architecture of the developed product will be determined by the market analysis information (software environment, web-based, databases, etc.).

3.1.1 3D CAD tools

Modern 3D CAD tools offer significant benefits and improvements in the following areas [2]:

- Shorter evaluation of different design alternatives due to the high level of topology that allows an automatic recalculation in case of upper-level modifications.
- The generation of a 3D model at early ship design stages allows taking decisions having real information instead of estimations. Early estimation of materials and weights, including welding and painting.
- Less risk of inconsistencies when compared to the 2D approach in which every view is independent and has no relation with the others. Instead, the 3D approach combines the implicit intelligence associated to the model using specific attributes (continuity, water tightness) with the graphical checking performed by the user leading to design with better quality.
- More natural link with analysis and calculation tools based on the existence of a single 3D model that, for other calculations, is subject to an idealisation process for easier management in the FEM/FEA tools. Most of these calculations are made during the basic design stage.
- The quick position of the most appropriate equipment helps in setting the most important spaces of the ship and also for weights and centres of gravity considerations.
- Due to the incremental development of the model as the design evolves, there is a seamless transition to detail design based on the reuse of data, which reduces the design time and simplifies the overall process.
- More accurate design due to the use of a 3D tool.
- Easier co-ordination among disciplines as hull structure and various disciplines of outfitting are represented in the same underlying product model. This has distinct advantages in terms of interference or collision checks and leads to a better outfitting design regarding the general arrangement definition and critical compartments layout.
- Having the 3D model at early ship design stages allows navigation around it using Virtual Reality viewers. This is an essential advantage for marketing activities or to control the design process in a very intuitive way.

The innovations above will be used to face the challenges that the future of the shipbuilding industry faces as well as new opportunities from world trade expansion. Shipping, as the leader of the world trade market, is transforming and facing considerable challenges in maintaining competitiveness. The shipping industry is continually searching for cost-effective technology and business solutions to ‘future-proof’ their fleet and assets. The rule of the market economy – constant operational change to meet changing customer needs – is forever putting pressure on ship operators. Technologies can help in solving the environmental challenges and improving operational efficiency in the business world of the 21st century. With the explosion of consumption demanded by the growing middle classes from developing countries, the demand for raw materials, food and energy production will increase. With land-based resources depleting rapidly, attention will necessarily turn to ocean space for alternatives; efforts here will require sustainable technologies to protect the environment [3].

3.1.2 Lifecycle Approaches

As part of the holistic approach during the design phase of a vessel, a number of lifecycle methodologies have been adopted by the shipping industry, in order to estimate all costs related to the entire life of a ship (from the cradle to the grave) and the assessment of the environmental impact of all activities related to a ship, from its construction to its dismantling. This trend has led to the development of LCC and LCA methodologies appropriate to be introduced in the design process.

3.1.3 Transformational Technologies

As the pace of technology development accelerates in the 21st century, the transition time between emerging and mature technologies continues to be shortened. In this new reality, the early identification of emerging technologies that will have significant value and impact on the commercial shipping, naval, and ocean space sectors will benefit policy- and decision-makers, helping them to make the right investment decision at the right time. It will also help to identify risks and opportunities.

The results of a set of foresight into global marine technology trends and their implications for the marine world in the year 2030 as reported by Lloyd's Register, QinetiQ and University of Southampton [3] are presented in the next figure.

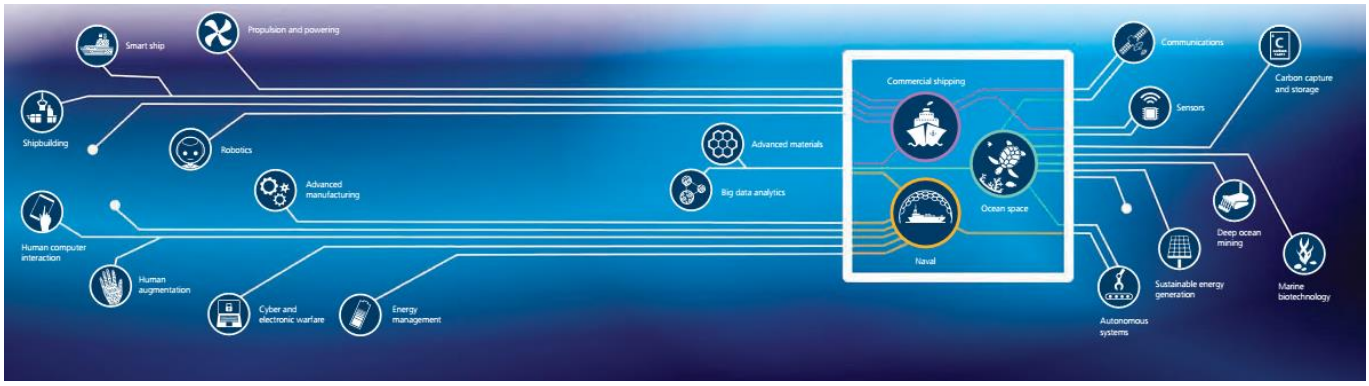


Figure 9: Interrelationship between marine technologies and maritime sectors [3]

Due to the specific characteristics of every transformational technology, some of them will only apply to one specific sector (commercial shipping, naval, ocean space), whereas others will apply to two of them, or all of them. Using colour coding and technology icons, the interrelationship between technologies and sectors show how every technology applies to a specific sector and shows those which overlap in different sectors. Figure 9 provides a holistic view as to how the transformational technologies will interact within the marine and maritime industries in 2030. More specifics on these technologies are presented next [3]:

- Big Data Analytics

Big data is data so large and/or complex that it is difficult to process using traditional data processing techniques and applications. The scale of the problem is well illustrated by the current estimate of a 4,300% increase in annual data generation by 2020. By 2030, that figure will have increased even further as this is an accelerating trend.

- Sensors

Sensor technologies are developing rapidly to meet the ever-growing demand for data and information that will enable consumer-driven needs. For example, The Internet of Things, which allows real-time monitoring and control of systems and processes, from home through to medical and industrial applications. These will also address the need for ever-increasing capabilities to measure the ocean (and near ocean) environment, including biological, acoustic and electromagnetic characteristics.

- Autonomous Systems

The focus in the marine industry at present is on improving safety by taking people out of dirty, dangerous and dull jobs. We expect to see a significant increase in the use of these systems in the marine domain in the future. Alongside 'stand-alone systems', we will increasingly see the use of interconnected intelligent systems to the point that utterly autonomous surface and underwater vessels become accepted.

- Robotics

Driven by improving safety, security, and productivity, the widespread adoption of robotics has been observed across various sectors. Future marine services and accelerating automation in the marine construction business will make robotics compulsory for tasks, especially those conducted in the severe working environment, such as deep ocean mining and disaster relief.

- Smart Ship

Smart ships are not a discrete technology, but a manifestation of the utilisation and exploitation of technology trends, many of which we elaborate on in this report (sensors, robotics, big data, advanced materials, communications and satellites). The application of these technologies will enable the transition into the smart ship era.

- Communications

People on board a vessel or on a platform rely on communication technologies to be socially connected to families and colleagues onshore. However, communication technologies are not just about supporting personal communication. They allow for emergency calls, geopositioning, marine-life tracking, and disaster warning. The increasing diversity and capability of communication technologies will enable the acquisition and connection of data from different sources, representing a key to open the big data door.

- Advanced Materials

The trend with all metallic, ceramic, polymeric and composite materials is to achieve improved capabilities such as strength, toughness, durability and other useful functionalities by designing it at the nanoscale and harnessing those properties in large structures. Desirable functionality, such as environmental sensing, self-cleaning, self-healing, enhanced electrical conductance and shape modification, is anticipated through the development of nanomaterials, and, in turn, will deliver performance benefits in the commercial shipping, naval and ocean space industries.

- Propulsion and Powering

As the demand for sea transportation increases, the global fleet is growing, and ships are becoming more substantial in size. While efficiency has improved in relative terms (due to economies of scale), in absolute terms, the powering demands for the propulsion and power generation of ships have increased. Combined with concerns over future fossil-fuel dependency and our environmental footprint, propulsion and powering will become a key focus of technology development.

- Shipbuilding

Global competition in the shipbuilding industry will remain intense. Such competition will drive advances in shipbuilding technologies, which are often propelled by innovation in the production process and the creation of new designs.

- Advanced Manufacturing

The key to this change is the ability to exploit and integrate adjacent technologies and business innovations, including: informatics which will apply information techniques to the manufacturing and logistics processes; automation and intelligent systems which will enable increased productivity, safety and quality; and simulation and visualisation techniques which will reduce the time from conceptualisation to production.

- Human-Computer Interaction

The technology enabling HCI has developed most rapidly on consumer devices, such as smartphones and tablets, which use multi-touch displays. In contrast, the majority of traditionally fixed workstations and personal computers still use the ubiquitous interfaces of mouse, keyboard and display. This is set to change, and by 2030 we can expect several new HCI technologies to replace or augment those we currently use, both in fixed locations and when on the move. These technologies will enable us to interact

with computer systems in new ways and will be smart enough to recognise our requirements and our personal preferences.

- Human Augmentation

Human augmentation technology will eventually merge the human body with the machine. Research is currently looking at device architectures that resemble the body's own musculoskeletal design, actuator technologies that behave like muscle, and control methodologies that exploit the principles of biological movement. Human augmentation's promise of improved human performance and the need for future navies to operate more effectively with fewer crew members will drive the technology's adoption. We can expect exoskeleton technology to be at the forefront of this adoption, but intrusive bions and neuro-enhancements will appear much later.

- Cyber and Electronic Warfare

The dependence of many activities on global navigation satellite systems for precision navigation and timing will drive the development of alternative precision positioning systems, such as combinatorial chip-scale clocks; cold-atom technology on the microscale; chip-scale nuclear magnetic resonance gyroscopes; and inertial measurement units based on cold-atom interferometry. An escalation in cyber and electronic warfare can be expected, and continued development of a suite of technologies will be needed to support electromagnetic stealth and resilience to electromagnetic attack.

- Energy Management

Energy management refers to the efficient production, storage, delivery and re-use of energy onboard vessels at sea. The technologies associated with the whole energy management system are particularly crucial in naval vessels where the demand for 'high-capacity surges' from energy-intensive systems will continue to grow between now and 2030.

- Marine Biotechnology

Oceans are vast reservoirs of food, energy, and other resources, representing a unique opportunity for innovations in pharmaceuticals, development of industries, and sustainable solutions. Marine biotechnology seeks to harness this potential through the application of technological tools to deliver products, services, and knowledge. Due to its interdependence on the fragile maritime environment, this technology must be used with particular consideration for preserving and nurturing the marine ecosystems.

- Deep Ocean Mining

The global turnover of deep ocean mining is expected to grow from almost nothing to 10 billion, where 10% of the world's minerals will be sourced from the ocean floors. The emergence of this new technology will lead to a progressive growth in markets that are already evolving to support deep ocean mining operations.

- Sustainable Energy Generation

The provision of sustainable energy serves the needs of the present without compromising the ability of future generations to meet their needs. These energy sources, including solar, wind, wave and hydroelectric energy, generate intermittent power. Marine energy carried by ocean waves, tides, salinity, and ocean temperature differences can be harnessed to generate electricity to power homes, transport and industries. A novel form of sustainable energy is the use of hydrogen as a fuel. Using the abundance of the oceans, it is possible to split seawater and harvest hydrogen for use on land.

- Carbon Capture and Storage

Carbon capture and storage involves capturing carbon dioxide CO_2 emissions, caused by human activities, ideally before they enter the Earth's atmosphere, then transporting and storing them securely in geological sites. Fossil fuels provide over 85% of the total energy supply and are projected to continue at that rate through to 2030.

3.1.4 Maritime Industry and New Orders trends

The international maritime industry presents fluctuations on the total new order intake, going through circular periods of high demand for new vessels and lower demand periods until the new orders are being delivered.

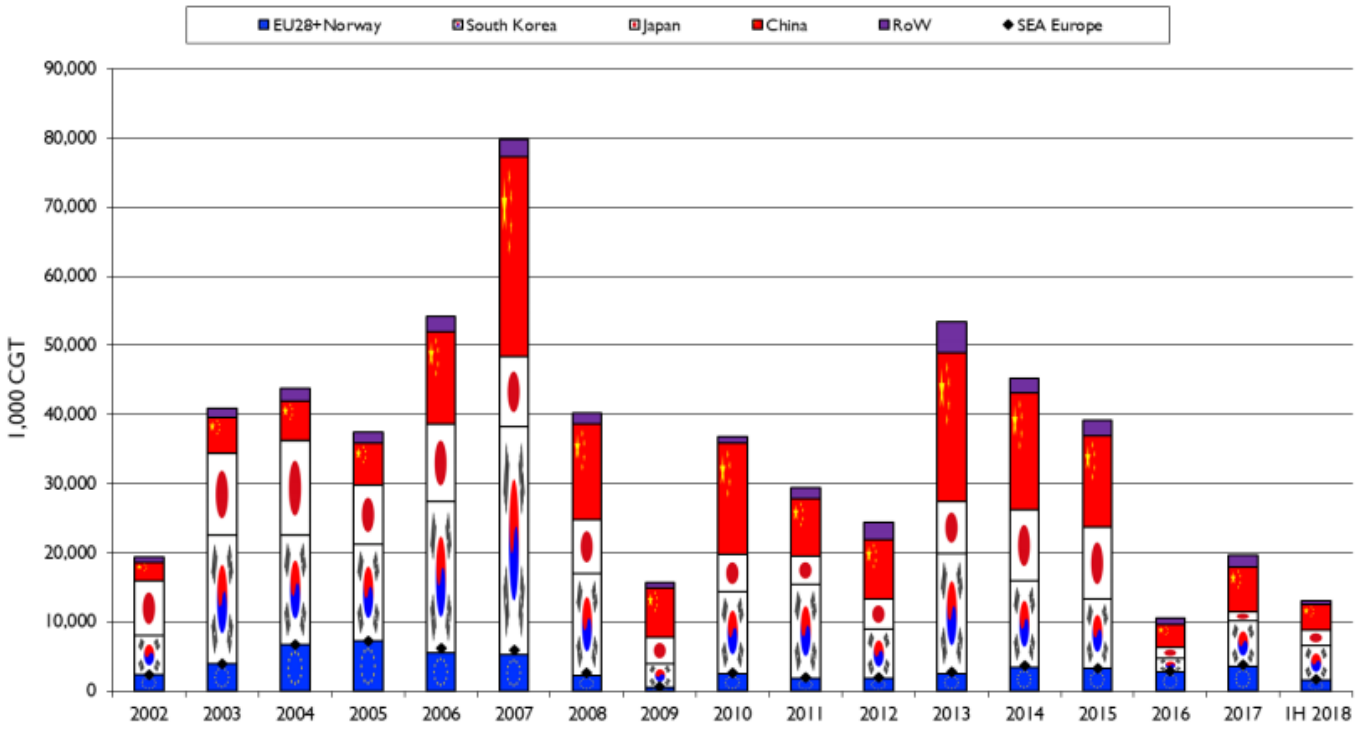


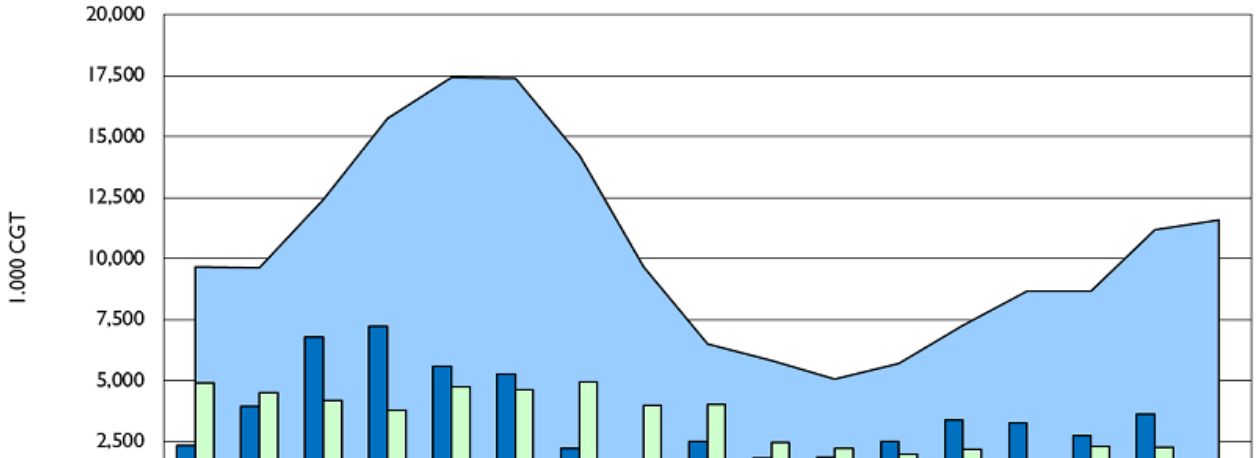
Figure 10: New Orders by Main Shipbuilding Areas (Source: IHS Fairplay) [4]

In 2017 the global new order intake increased compared to 2016 mainly driven by active recovery in crude tanker and bulk carrier ordering, but it remains at a historically low level. The same conclusions apply for the EU shipbuilding sector, although the level of changes is significantly lower.

In the 1st Half of 2018 (1H2018) the global new order intake volume doubled compared to 2017 mainly driven by active recovery in some markets (crude tanker and bulk carriers) but remained at a historically low level, and there is a significant reduction of shipbuilding orders in the EU.

Figure 11: Sea Europe – Shipyards' and Maritime Equipment Industry [5]

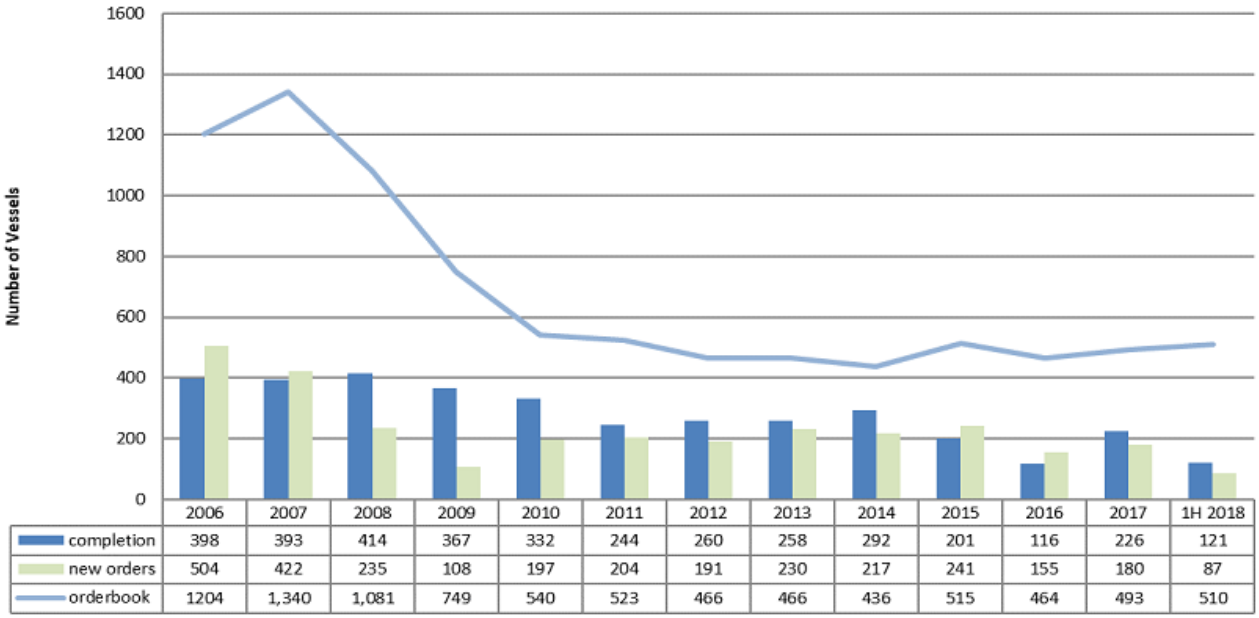
The total worth of the European industry is estimated at 91 billion €, split into its various business sectors.



	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	1H 2018
orderbook	9,666	9,610	12,406	15,738	17,430	17,376	14,209	9,647	6,495	5,836	5058	5,705	7,247	8,678	8,645	11,176	11,598
new orders	2,341	3,951	6,798	7,226	5,597	5,257	2,229	571	2,487	1,830	1,859	2,515	3,394	3,258	2,745	3,639	1,615
completions	4,896	4,498	4,194	3,766	4,762	4,637	4,962	3,966	4,020	2,474	2,232	1,975	2,179	1,677	2,322	2,262	1,335

Figure 12: Summary of activity of EU28+ Norway shipyards in CGT (Source: IHS Fairplay) [2]

The European order book continues growing since 2012 reaching at the end of June 2018 an estimated 11.6 M CGT (510 units). A total of 87 vessels of 1.6 M CGT have been reported ordered at European yards in 1H 2018. European yards continue to harvest the benefits of their specialisation and strong focus on high tech niche markets, with a few benefiting from the extraordinary cruise ordering boom. While some yards are gradually trying to enter the small/expedition cruise segment in a bid to diversify their business, others continue to struggle due to persistently weak (albeit slightly improved) ordering levels in other markets, e.g. offshore [2].



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	1H 2018
completion	398	393	414	367	332	244	260	258	292	201	116	226	121
new orders	504	422	235	108	197	204	191	230	217	241	155	180	87
orderbook	1204	1,340	1,081	749	540	523	466	466	436	515	464	493	510

Figure 13: EU28+Norway commercial shipbuilding activity in No. Of vessels (Source: IHS Fairplay) [2]

After the decline in total estimated investment recorded in 2016, global newbuild investment increased in 2017 across most vessels sectors reaching an estimated 62.0 bn$, which represented a year-on-year increase of 65% on full-year 2016 levels. European new contracts accounted for 22 billion $ (Figure15), 35% of the total value of global new orders. [9]

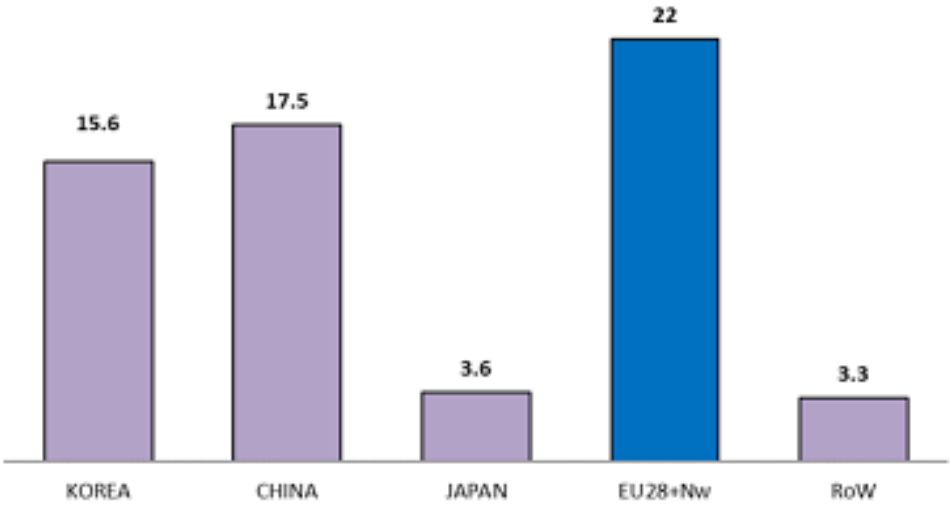


Figure 14: 2017 Value of new orders in bn $ [9]

In the first half of 2018, global shipyard output in value terms accounted for 38.5 billion dollars, while the value of newbuilding deliveries by European shipyards (including Norway, Turkey and Russia) is estimated at 6.9 billion dollars, 18% share of the global market.

Global newbuilding investment reached an estimated total of $28.2bn in the first half of 2018, representing a 14% year-on-year decline on an annualised basis. Contracts placed at European yards (plus Norway, Turkey and Russia) have a combined estimated investment value of $6.1bn, accounting for 22% of global investment (Figure16). [2]

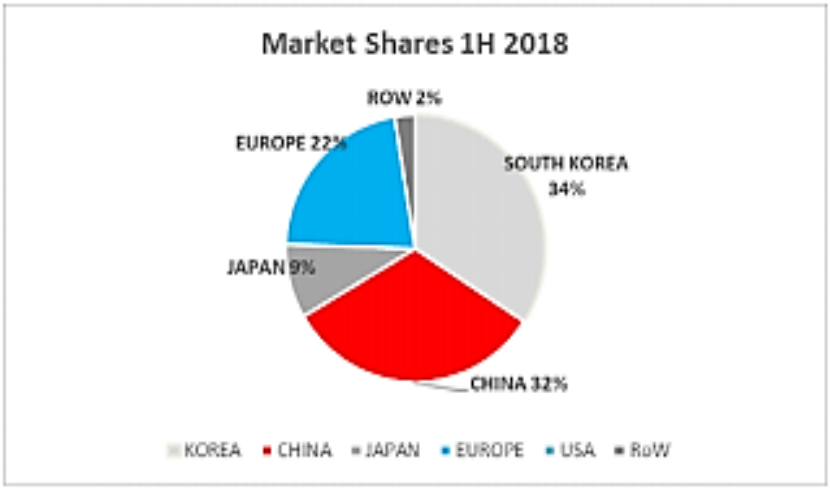


Figure 15: Value of the New Orders by primary Shipbuilding Areas (Data Source: Clarksons) [2]

Additional studies have calculated and presented forecasts for newbuilding demand the following years. BALance Technology Consulting GmbH has estimated market forecasts based on specific ship-types, as shown in the following table. For the forecast period 2016-2025, the aggregated numbers show an annual average delivery of 2.475 ships, representing 52.1 mDWT, 40.1 mGT and 28.9 m cGT. By using price trends from the last ten years, the overall annual average market value has been calculated to USD 91 .6 billion. However, this is not necessarily evenly distributed over the years [6].

Table 1: Ship newbuilding demand forecast [6]

Forecast of overall annual average market value 2016-2025, world (Billion, USD)						
Total Shipbuilding	**Bulk Carrier & Container**	**Tankers**	**Passenger Cruise**	**Passenger Yacht + Ferry**	**Cargo**	**Others**
91.6	17.5	17.7	6.3	5.9	9.1	35.1

The above categorisation clearly shows that although by far the biggest market in size (88% in DWT and 78% in GT), the Bulk Carrier/Container and Tanker categories represent only 38% of the market value in USD. In comparison to this category, passenger and offshore vessels represents about 52% of the market value in USD, but only about 12% of the forecast in GT.

In the following table, the production and purchasing values of the shipbuilding and boatbuilding industries as well as the 1st and 2nd tier suppliers[2] of the shipbuilding supply chain have been analysed in terms of value added, imported and domestic purchase values as well as domestic and international sales.

[2] 1st tier suppliers offer the most advanced processes in the supply chain, while 2nd tier companies usually supply 1st tier companies with their products

Table 2: Overall shipbuilding supply chain portfolios (2010-14 average) [6]

EU 28 shipbuilding supply chain portfolio	
Production and purchasing values (bn €)	41.07
intra EU export (bn €)	6.3
extra EU export (bn €)	10.5
Companies Shipbuilding	3.803
Employees	117.778
Companies Repair	14.542
Employees	64.890
1st tier supplier	44.5
Companies	28 000
Employees	231 000
2nd tier supplier	26.8
Employees	109 000

Shipbuilding generates an overall production value of 41 billion €, employing 225.000 people in more than 22.000 companies. With an overall production volume of 44.5 billion per year, the 1st tier of the shipbuilding supply chain reaches an even higher production value building on their high production values for export. While goods and services worth 6.3 billion € are exported intra EU 28, a production value of 10.5 billion € is exported outside the EU 28 countries (extra EU export). The 1st tier of the shipbuilding supply chain engages more than 231.000 employees in more than 28.000 enterprises across Europe. The economic strength of the 1st tier suppliers within the European shipbuilding supply chain in combination with the distinct intra-European trade is responsible for a powerful group of sub-suppliers in the 2nd tier of the shipbuilding supply chain. The analysis estimates a total production value of 26.8 billion € for the 2nd tier suppliers and additional 109.000 employees [6].

Statistical estimations of the number of European (plus Turkey) marine supplies companies and average market volumes are presented next.

Table 3: EU28 plus Norway and Turkey: Marine supplies industry average estimations (2013) [8]

EU28 plus Norway and Turkey: companies of marine supplies industry	29.087
EU28 plus Norway and Turkey: companies of marine supplies industry with low size (less than 10 employees)	8.380
External Services (Engineering, design and consulting services)	22 bn € per year
Market Volume Repair and Conversion (EU)	3-4 bn € per year
Market Volume Repair and Conversion (Global)	18.5 bn $ per year

The total market volume for maintenance and repair of the world merchant fleet is estimated at 18.5 bn USD, of which 50% is estimated to be labour cost (shipyard or shipping companies) and another 50% is estimated to be spare parts (material, equipment including subcontracts for supply companies). [8]

3.1.5 Energy efficiency in shipbuilding

The objectives of European energy policy are the construction of appropriate cross-border interconnections, diversification of supply sources and routes, promotion of energy efficiency, and the acceleration of the transformation to low-carbon energy. Their strategic importance is reaffirmed in the overarching Europe 2020 strategy for smart, sustainable and inclusive growth in the EU and in its flagship initiative entitled 'resource-efficient Europe'.

Table 4: International peer evaluation on trends in innovation [8]

Ranking of Importance for innovation as an influence to the retrofitting and repair market						
Energy Efficient Ship	**Environmental Friendly**	**New Ship Types**	**Life Cycle Management**	**Innovative Systems & Components**	**Ship Safety & Security**	**New Materials/ Light Weight Structure**
84.6%	83.8%	78.6%	72.6%	72.6%	72.2%	68.8%

Stakeholders of the international shipping industry consider energy efficiency, environmentally friendly ships and new ship types as of the highest importance for innovation in ship technology (Table4). The owners of the global fleet are forced to invest in new vessels or retrofit the old ones to meet the current international standards and restrictions for shipping including the international and national environmental regulations.

In this context, the European shipping market must promote innovative green technologies and technical specialisation in shipping trends, to preserve and further extend its share in the global shipping market.

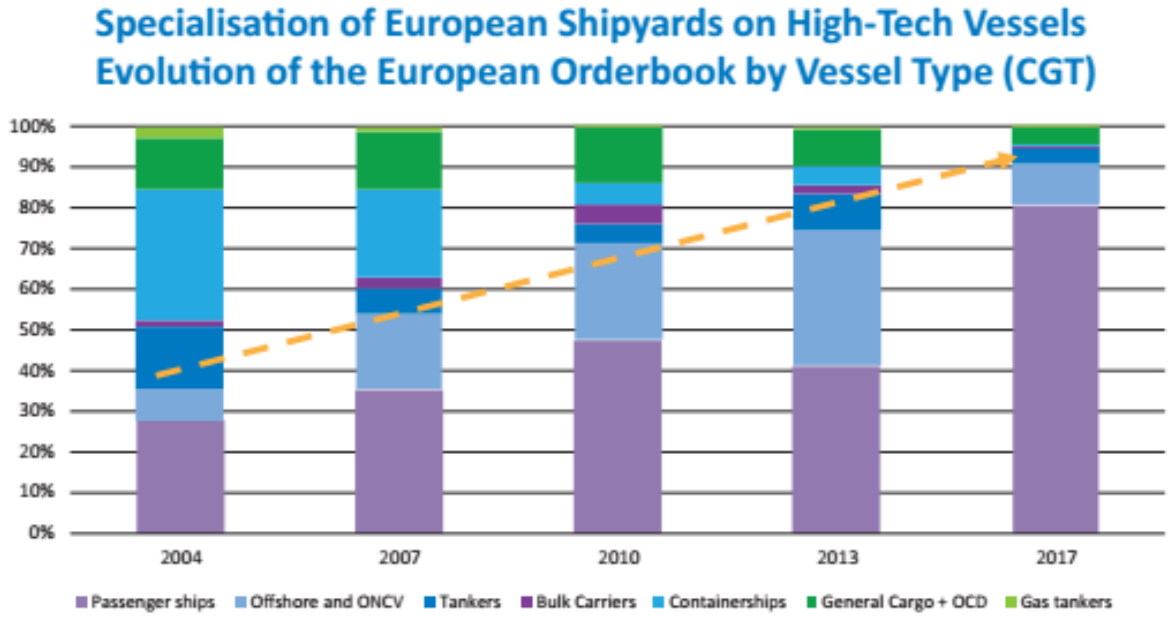


Figure 16: Specialisation of European Shipyards (Source: IHS Fairplay) [1]

The European order book by ship type shows the progressive specialisation of European shipbuilders in high-tech, sophisticated vessels (e.g. passenger ships, ONCCV). In 2017, these accounted for over 90% of the European order book (Figure17). European yards continue to harvest the benefits of their specialisation and successful focus on high tech niche markets, with a few benefiting from the extraordinary cruise ordering boom.

All main actors in the shipbuilding value chain play a significant role in the innovation process. Actors differ very much in size and role and some cases are not split but integrated into a single party (e.g. design activities directly undertaken by shipyards). Nevertheless, with keeping these limitations in mind, several critical roles can be distinguished (Figure18).

Figure 17: Value chain of the shipbuilding industry [7]

Design offices can play an essential role as the conceptual design is crucial for a vessel's operational efficiency. They usually collaborate with shipyards (or are integrated into a shipyard) to develop a ship design which matches the operational criteria set by either the yard or the owner. In some cases, also large ship owners/operators undertake design activities.

The marine equipment industry contributes to innovations through particular components that can make the difference for the total performance of the ship and/or operational costs. In general equipment suppliers are seen to be a major actor in innovations. The role of the supply industry is significant in ship production as the value of today's ships consists of 50-70% (or more) of subcontracted supplies and activities. [7]

Regarding shipyards, the current economic crisis has led to reduced demand for new-built ships and has turned from a "sellers" market to a "buyers" market. This implies that innovation emphasis is put on efficiency, reliability, performance, standardisation and cost-cutting as these are "safe bets". This strategy is especially relevant for shipbuilding companies serving mass segments like container ships, tankers and bulkers, segments that are dominated by Asian yards. [7]

Ship owners are the primary decision-makers in the shipbuilding industry value chain. They are the ones that take the purchasing decision and consequently have the power to decide to invest (or not) in innovations. Ship owners also decide when to invest. In 2008, European ship owners accounted for over half (52%) of the entire demand for newbuild ships (whereas the share of European shipyards in the total global order book value at that time amounted to 13%). [7]

Cargo owners select a particular shipping company to ship their goods. A significant factor in this decision is cost. However, recently, the 'green' argument has gained importance and is also influencing the decision of some cargo owners. For example, some cargo owners demand that their goods are being transported on a 'green' ship. This implies that the cargo owner can put pressure on the ship owners to make an effort in 'greening' their ships and thus allow innovation to happen. [7]

Classification societies are essential as they set standards and supervise rules in the shipbuilding industry. In principle, class societies check whether the products and systems on board of a ship comply with the standards and regulations or not. They set and apply technical standards relating to the design and construction of ships and carry out extensive surveys of ships and their central systems. [7]

3.2 Target market

According to Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E)[3] [10], in 2017, within EU-27 countries, there were approximately 8.300 enterprises registered under NACE Rev. 2 C301

[3] EUROSTAT, last update from March 2019

"Building of ships and boats". Around 17.000 enterprises were registered in 2016 under NACE Rev. 2 C3315 "Repair and maintenance of ships and boats".

Eurostat statistics[4] [10] in 2015 show that SME represents around 99,8% of all enterprises. The same trend can be found within the NACE class 30.1 Building of ships and boats.

Apart from the companies registered under NACE C3511, a large number of small and medium-sized supply companies are in the marine equipment industry. Their number is estimated between 5,000 and 7,000 companies in Europe alone [11].

Additional information on the population of the European repair maritime sector, the global naval engineering and the suppliers of software solutions can be found in the following table:

Table 5: Accumulated number of companies of shipping sectors [12] [13]

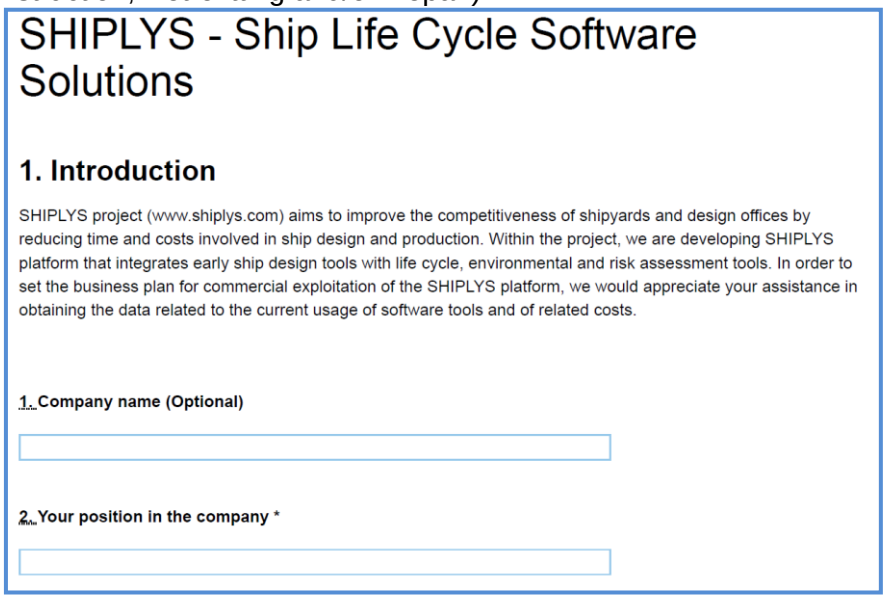
List of European Repair Shipyards (accumulated)	296
List of Naval Engineering Companies (global)	230
List of Suppliers of Software Solutions (global)	162

3.3 Questionnaire addressed to market stakeholders

3.3.1 Description of the Questionnaire

A questionnaire was prepared to obtain the data related to the usage of software tools in the shipyard design office and related costs. The participants have been asked for some basic information about the company, i.e.:

- Type of company (Shipyard or design office)
- Number of employees and the average size of the design office if applicable
- Shipbuilding processes within the company (Preliminary / Concept design, Basic design, Detail design, Construction, Retrofitting and/or Repair)


SHIPLYS - Ship Life Cycle Software Solutions

1. Introduction

SHIPLYS project (www.shiplys.com) aims to improve the competitiveness of shipyards and design offices by reducing time and costs involved in ship design and production. Within the project, we are developing SHIPLYS platform that integrates early ship design tools with life cycle, environmental and risk assessment tools. In order to set the business plan for commercial exploitation of the SHIPLYS platform, we would appreciate your assistance in obtaining the data related to the current usage of software tools and of related costs.

1. Company name (Optional)

2. Your position in the company *

Figure 18: Screen capture of the Questionnaire addressed to the market stakeholders

[4] EUROSTAT, Statistics on small and medium-sized enterprises

The primary purpose of the questionnaire was to investigate which software tools and how many of them are being used within the shipyard design office. Therefore, the participants have been asked to specify which software tools they use for each functionality related with the SHIPLYS platform and to describe the type of licence and approximate price of the tool (Table 6).

Table 6: Questionnaire – Usage of the software tools

Functionality	Software tool	Cost (EUR)	Licence type (full or monthly based)	Number of licences
Tender requirements identification				
General ship configuration: Main dimensions and parameters estimation				
Hull form generation				
General arrangement				
Hydrostatic calculations				
Hydrodynamics and powering				
Ship structural configuration: Definition of the decks and bulkheads, weight, volume and centre of gravity calculations				
Stability analysis				
Determination of scantlings				
Loading conditions and sea keeping analysis				
Main equipment data sheets and requirements				
Production simulation				
Life cycle cost / environmental assessment				

Finally, the participants have been asked to approximate their company's yearly expenditure on software tools. The example of the questionnaire can be found in the Appendix.

3.3.2 Results

The questionnaire has been distributed amongst project consortium and a stakeholder advisory committee. Also, each of the partners has distributed it to their relevant contacts. Due to the complexity of the questions or the reluctance to disclosure the company's information, the results showed only 10 valid responses.

Nevertheless, the three partners representing market stakeholders within the consortium gave their feedback on software usage.

Only 10 responses can't be a measurable sample to set the business plan or a price for a SHIPLYS platform, but it can approximately give us an insight on how some shipyards and design offices use the software tools within their company.

The summary of the results is given in Table 7.

Table 7: Summary of the questionnaire's results

Number of responses	**10 (6 shipyards, 3 design offices, 1 university)**
Average number of different software tools used within company	3
Average software expenditure per year within design office	18.000 EUR
Average software expenditure per year within shipyard that has its own design office	15.350 EUR
Total number of different software tools used	18

Figure 19 shows the distribution of the type of licences used within the companies, and it can be seen that 72% use software tools with a full licence, and 28% of them use software tools with monthly or yearly subscription.

Regarding the functionalities that each company uses, most of them use some tools for hull form generation, general arrangement, compartment definition and the determination of weight and centre of gravity (see Figure 20).

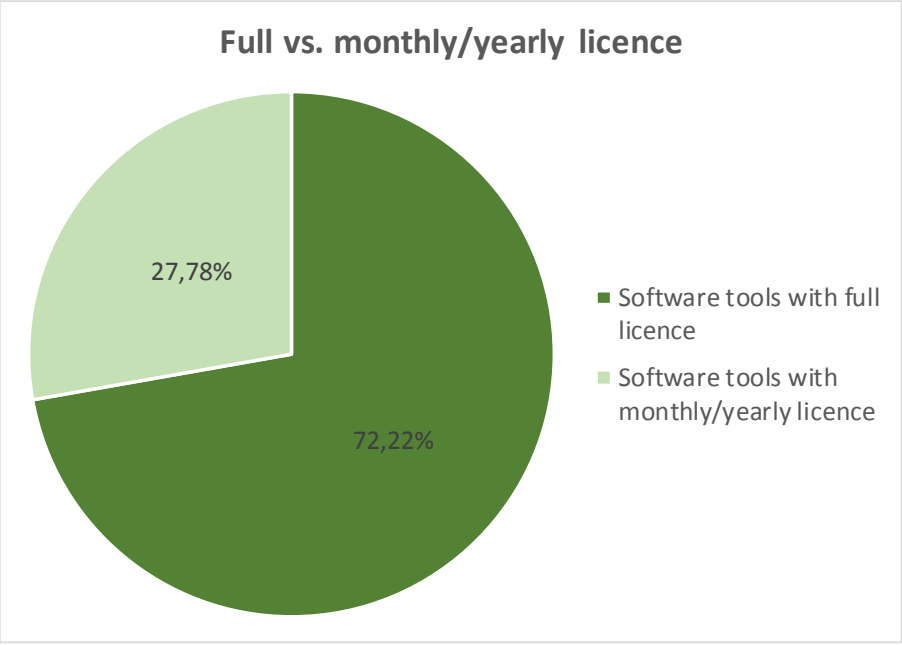


Figure 19: Pie chart showing the percentage of companies that use full or subscription licence

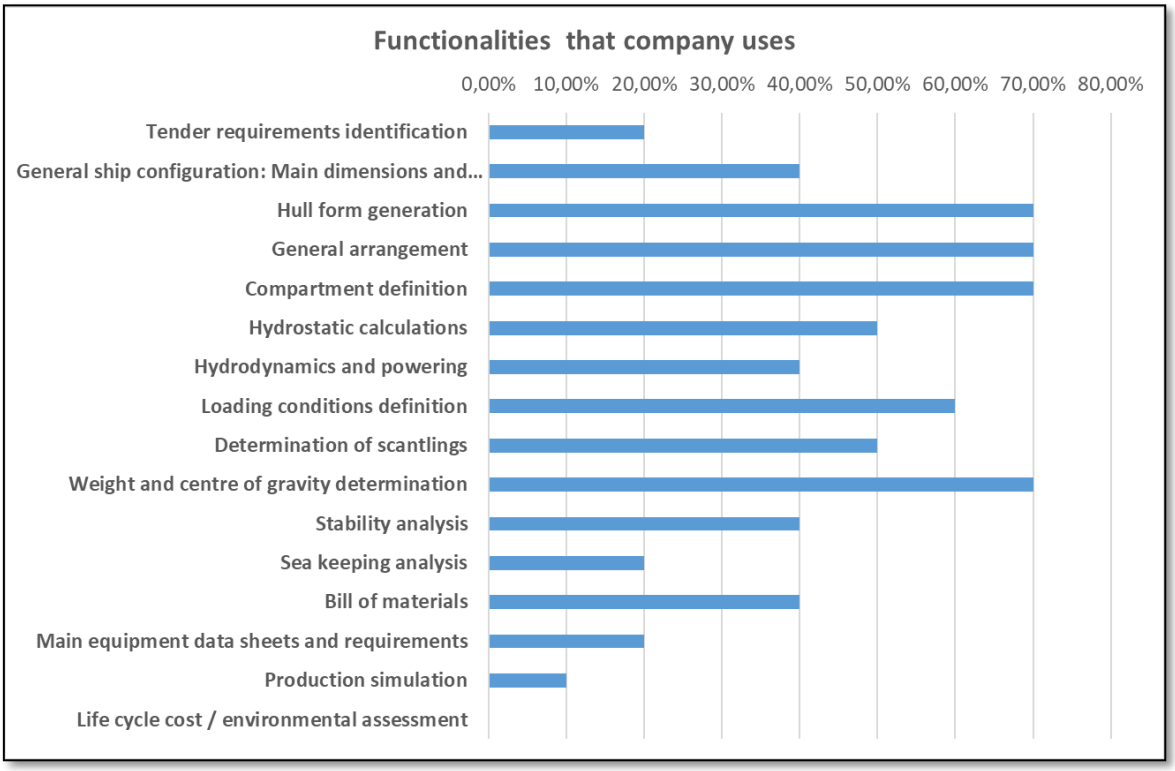


Figure 20: Chart showing how many companies use each of the functionality related to the SHIPLYS platform

Some of the tools that are being used within these 10 companies are AutoCAD, NAPA, Maxsurf, Cadmatic, ZWCAD, CAFE.

3.4 Competition of the SHIPLYS tool

Not many similar or as comprehensive products as the SHIPLYS tool are available in the market today. Most of the available software tools used by the shipbuilding industry only incorporate specific procedures of the ship design process and use parts of the modules integrated into the SHIPLYS platform. Not many of the available systems provide a parametric modelling capability, but they all include scripting or a programming language which allows the user to develop some automation codes used for parametric modelling of the hull form[5].

The global engineering software market defines the use of different software such as computer-aided designing (CAD) software, computer-aided engineering (CAE) software, computer-aided manufacturing (CAM) software, electronic design automation (EDA) software, and architecture, engineering, and construction (AEC) software. The global engineering software market was valued at US$ 19.98 billion in 2014 and is forecast to grow at a CAGR of 12.4% from 2015 to 2022 [15].

One of the most well-known software tools used in the target market is **FORAN.** It is a system used in the design and construction of vessels and marine structures, developed by SENER and currently licensed at more than 150 shipyards and design offices in 40 countries [14].

The key aspects of a Shipbuilding CAD System are [2]:

[5] The listed information are presented on the SHIPLYS SIS Collection-rev.2 document and the Ship Design Software list in Deliverable D3.1 Existing prototyping models and approaches in shipping and other industry sectors unless stated otherwise.

- Database: It is built on top of a relational database which ensures a single accurate source of data during the whole design process.
- Topology: The possibility of introducing quick changes that can be propagated through the model with a single click is possible thanks to the topological approach. This is specifically relevant at early ship design stages, when significant changes are introduced into the project, and where important decisions need to be made having as much real information as possible.
- Integration: All disciplines are integrated in a single environment. So, the early 3D model of the structure is generated with the same tool for the detailed approach. The reuse of information is critical. Thanks to this, the amount of effort during the detail design stage is substantially less.

The development of the hull form is a task carried out using software tools that can be either generic CAD systems with surface modelling capabilities able to deal with free-form shapes or specialised systems for naval architecture. The following software tools are representative of this specific process [16]:

Autoship

Autoship Systems Corporation (ASC) provides CAD/CAM software for vessel design and construction, on-board strength and stability monitoring and customised load and stowage planning. ASC's On-board and Load Planning software, Autoload® is used at all stages of vessel operations Ashore, the load planning modules are interfaced with the in-house booking systems and are used to create load plans which are then transmitted back to the vessel thus allowing more optimal loading in a shorter time.

DELFTship

Combining an accurate and fully 3D model of the vessel, cutting edge technologies and highly optimised graphical user interfaces into software that is easy to operate and very accurate.

Market price: EUR 150 for DelftShip Professional.

Maxsurf

Software interface with a large collection of tools and add-on modules is used to improve the hull surface fairness and refinement of the hull, the addition of appendages, compartmentation, etc.

Market price: $700 - $6000 depending on the number of surfaces (3, 6, unlimited)

MultiSurf

It’s a computer-aided design (CAD) package with the ability to create freeform surface shapes.

Market price: Full Version: $4000+, LT (10 surfaces) $1000.

FastShip

The ship motion analysis capability includes motion simulation in both frequency domain and time domain, use of linear and nonlinear methods, prediction of small/moderate amplitude motions as well as large amplitude motions leading to capsize. It can handle the traditional mono-hulls such as naval surface combatants, commercial oil tankers, bulk carriers, LNGs and container ships, barges, but also drilling ships, Floating Production Storage and Offloading (FPSO), SPAR, riser and other offshore production platforms as well as high-speed, more advanced and challenging hull forms such as high-speed planing boats, catamarans and air-cushioned surface effect ship.

Market price: $250

ProSurf [Also ProBasic (10 surface version) and ProChine]

Software for computer-aided boat & ship design and construction. The Nautilus System developed by New Wave Systems is an integrated set of computer programs for defining, fairing, analysing, and constructing any boat or ship.

Market price: $395 full version, add on modules available ($195 ProBasic, $95 ProChine).

RHINO

3D surface editor primarily used when working with hull forms. Capable of handling IGES and STEP files amongst many others. It uses the grasshopper facility for fairing. It is available with a downloadable installer, and its price depends on scope delivered.

TouchCad

Fast and precise push-pull free form 3D modelling, ability to add and delete control points anywhere on the surface.

Market price: EUR 2000

CATIA [3DS]

One of the most common CAD-tools used for 2D and 3D design and engineering. It delivers the ability not only to model a product but to do so in the context of its real-life behaviour: design in the age of experience. Systems architects, engineers, designers and all contributors can use it.

CAESES

One of the most powerful tools for parametric geometric modelling that can be used for the generation of ship's hulls is the Modeler, one of the components of the CAESES (www.caeses.com), a commercial system previously known as Friendship Framework, based on B-spline curves and surfaces. This system has introduced a new concept of the curve, the k-spline [17]. This curve can be created by interpolating several data points while simultaneously complying with some integral properties such as the area under the curve and is inherently smooth which makes it a powerful tool to model cross-sections of the hull in compliance with the area up to the design waterline defined by the SAC.

Paramarine

The software Paramarine has been indicated as a platform with similar characteristics to the SHIPLYS tool. Paramarine is a software package developed by QinetiQ MDS, a company established in the UK. It is described as a "fully integrated Naval Architecture Design and Analysis product that can handle the complexities of the ship and submarine design" [18].

The software package offers integration of multiple analytical tools covering:

- Concept Design.
- Stability Assessment, both damaged and intact.
- Manoeuvring performance.
- Powering and Endurance.
- Seakeeping.
- Structural Analysis.

All software solutions are supported by a range of training and design support services.

The market price for the acquisition of the software is 11.000,00 €.

Siemens PLM

Finite element analysis and modelling, model visualisation, digital simulations, CAD-independent, linear static analysis, buckling, steady-state and transient heat transfer, basic nonlinear analysis [19].

Siemens has also initiated a collaboration with DNV GL aiming to optimise hull efficiency and predict annual fuel savings up to $3 million per ship under study. Optimising ships used to take a design-perspective approach that focused on best performance at design draft/speed; the collaboration promotes a different type of optimisation, targeting various speed and draft combinations as described in the operating profile [20].

CADDS 5

Creo CADDS 5 is a hybrid modelling solution that let users optimise their design approach for specific cases. You can leverage parametric, explicit, and derived modelling capabilities which are tailored to meet the needs of shipbuilders and other designers of extensive, complex products. Creo CADDS 5 facilitates collaborative engineering, enabling designers to work concurrently on a design project, enabling simultaneous design, documentation, assembly and machining [21].

NAPA

Flexible and efficient design tool from the contracting phase through to detailed design phase, enabling rapid design changes and optimisation. Primary functions include hull surface editing, hydrostatics and stability calculations. Can be used as a standalone system and can be combined with various Classes' software like Lloyd's Register's RulesCalc etc.

NAPA's philosophy is that true eco-efficiency starts with the design process and continues through a vessel's operational life-cycle. To achieve maximum energy efficiency and optimal design, both the hydrodynamic performance of the hull form and the required capacity and mission of the vessel must be considered [20].

FORAN

FORAN is a system used in the design and construction of vessels and marine structures. It encompasses every aspect of design in a fully integrated manner, and it is used at every stage of the design and production of a vessel.

FORAN uses SENER's engineering and ship design know-how, as SENER is a company that offers services of this kind and that has also developed a marine design system. Key features [11]:

- Suitable from concept design to production.
- It is an integrated, robust and multidisciplinary system.
- It is easy to install, learn and use.
- It allows for fast, advanced modelling.
- It provides high performance, scalability and data integrity.
- It is open to other systems and applications.
- It has concurrent and distributed engineering.
- It focuses on automation.

AVEVA

AVEVA Outfitting Supports an add-on module for AVEVA Outfitting. It enables the efficient creation and adjustment, within the 3D ship model, of fully-defined supports of the types used in shipbuilding for piping, HVAC ducts and cable trays. Supports are modelled in an interactive, semi-automatic manner, according to user-defined rules and in the context of the 3D layout of the systems and the supporting plates and stiffeners. Outfitting Supports offers a full range of support standards for each discipline. An extensive catalogue enables predefined parametric components and objects to be quickly selected and positioned within the model, then automatically checked for clashes and compliance with configurable design rules. Changes made as the design can be highlighted and tracked, making it easier to identify, manage and communicate the changes across the different disciplines.

Market price: 30.342,00 € cost of a licence for AVEVA Outfitting / 6.066,00 € per year for maintenance.

CADMATIC

CADMATIC has different modules for system modelling:

OUTFITTING BASIC DESIGN SUITE: Cadmatic 3D Outfitting Basic Design suite is an integrated, database-driven design module and provides powerful tools for 3D layout -piping-, HVAC-, cable

tray- and structural unit design in shaded and coloured views. It produces information for installation and ordering materials. The Outfitting Basic Design suite includes the Diagram module.

OUTFITTING DETAIL DESIGN SUITE: The Outfitting Detail Design suite includes all the functionality of 3D modelling of the Basic Design suite. Additionally, the Detail Design suite has a full package of modules for production information: spools and ISOs, duct stools, support design, electrical design and integration with Hull modules

SHIPCONSTRUCTOR OUTFITTING

The ShipConstructor software product line consists of several task-based applications. These core products can be licensed in a modular fashion or as a complete package as part of a Universal License Therefore, ShipConstructor consists of several program modules, each of which can be purchased separately. Each of these is a product that is integrated into AutoCAD.

SOLIDWORKS [3DS]

Solid modelling CAD and CAE computer program for ship design, providing fast modelling capabilities, ship design calculations, 3D ship and equipment models importation, automatic generation of classification drawings, the rapid and parametric definition of shipbuilding entities, FE models, automated meshing and FE analysis. It is available to partners of the project for free.

NAVCAD [HYDROCOMP]

Used for the design and analysis of virtually any type of mono-hull or catamaran – from large displacement vessels to fast planing craft. Its features are bare-hull resistance prediction, steady-state propulsion analysis, added resistance, propeller selection, hull-propulsion interaction, vessel acceleration and supplemental analyses. It can be used by naval architects and designers hydrodynamicists and researchers, ship and boat builders, propulsion equipment manufacturers, navies, coast guards and schools.

Classification Societies Rules Structural Modules

An important requirement of basic hull design is to ensure safety and performance concerning structural strength, as well as to rapidly respond to inquiries from the shipowner or another basic design section. The principal classification societies have developed software packages for use by shipyards and design offices that incorporate dynamic-based criteria for the scantlings, structural arrangements, and details of ship structures. Some of these software packages are SafeHull (ABS), CSRS (ABS-LR), MARS2000 (BV), VeriSTAR Hull (BV), POSEIDON (DNV-GL), Nauticus Hull (DNV-GL), Sesam GeniE (DNV-GL), ShipLoad (DNV-GL), RulesCalc (LR) and ShipRight (LR).

In comparison with existing tools, the SHIPLYS platform offers advantages in:

- Efficiency of ship design processes
- Modularity
- Life cycle assessment
- Fast and cost-effective evaluation of alternatives
- Rapid early design
- Simulation tools
- Multi-criterion decision analysis
- Data availability
- Ability to integrate additional software tools

4 SHIPLYS Business plan

4.1 Exploitation plan

The exploitation plan will be developed regarding the commercialisation of the SHIPLYS platform and the tools produced during the implementation of the SHIPLYS project.

The specific exploitable project results are foreseen as being:

- Virtual prototyping methodology that integrates with lifecycle predictions.
- Data interoperability standard format definitions, compatible with the ISO Application Protocols.
- Life cycle cost analysis (LCCA) module, environmental assessment module enabling Life Cycle Assessments (LCA), risk assessment module and the decision support module, all integrated and tailored for shipbuilding application.
- Database architecture and initial population for shipbuilding product model build.
- Methodology for data quality evaluation and optimisation, to increase the database effectiveness over time.

It is proposed to introduce SHIPLYS software tool initially into a carefully selected group of partners within SME shipyards and their design supply chains, to build a base for a full-scale rollout in the intermediate term (5 years). These SME partners may be offered preferential payment terms, or potentially hire-purchase or rental terms, in exchange for providing early adopter stance, information capture and publicity from their operations. One key focus will be on the service offering (installation, maintenance, training, etc.) to ensure a high level of satisfaction among the first set of customers to build a word-of-mouth reputation.

The initial installation of the software to an affirmation group (5-10 installations) will lead to the growth of sales out into European commercial markets through the strategic conversion of the opportunities identified in the market setup work. The following sale activities will target those potential partners that could not take up the initial offer, due to wrong timing in their development cycles or other factors such as financial problems.

Next, a comprehensive market strategy plan will be designed to reach more potential customers of the shipping community and achieve the goals that will be set by the corporate organisation exploiting the SHIPLYS software.

Specialist design software companies, naval architecture offices, shipyards and ship owners across Europe will be approached for the dissemination of the SHIPLYS product tool.

4.2 Project benefits and future exploitation from different aspects

The SHIPLYS software will be available to buy or license after the completion of the project. It is anticipated that one member of the project will be selected to maintain and sell/license the software with a royalty paid to members based on their background IP and contribution to foreground IP.

The platform developed under the project offers several significant benefits for its users and other software designers:

- SHIPLYS will enhance SME capability to face an increasingly competitive market in the shipping sector.
- Offers an important tool in the initial bidding process.
- SHIPLYS will provide tools to improve safety and sustainability from a life cycle perspective.
- Multiple tools for different procedures of the ship design will offer a more detailed first illustration of the vessel’s compartments.

- The user will be able to use different modules for the same procedure as a confirmation of the produced results.
- Along with new innovative modules, already tested and validated software are included in the platform.
- Other software developers will be able to integrate their tools to the SHIPLYS platform.
- Software developers will be able to promote their software tools through the SHIPLYS platform expanding their customer base and market infiltration.

Furthermore, the SHIPLYS project has contributed to the research and the development of shipbuilding tools and processes by supporting several PhD researchers and has generated added value for the EU shipbuilding sector by bringing together shipbuilders, ship design offices, ship owners and ship operators, IT developers and universities/institutes.

The future exploitation of the SHIPLYS platform will give the chance to continue the research in advanced shipbuilding technologies and to develop further innovative tools required by the shipping industry.

4.3 Partners' involvement in commercial exploitation of the project results

The SHIPLYS partners that have expressed their interest in taking part in the exploitation of the SHIPLYS platform and the different tools created within the project are AES, as2con, BMT, IST and UStrath.

Figure 21: Partners taking part in the exploitation of the SHIPLYS platform

TWI Ltd. has stated that they will happily support the exploitation plan of the SHIPLYS project after its completion and Ferguson ME Ltd. is keen to integrate their software into the platform for the design process.

4.4 Business models

In order to set up suitable business models for commercialization of the SHIPLYS platform, a short Questionnaire with the most important topics that need to be clarified regarding the exploitation of the SHIPLYS platform has been created. This questionnaire was circulated to the SHIPLYS partners to record their opinions on the related subjects. More specifically, the questionnaire began with a short description of different business models followed by several questions related to basic subjects of the business model. The opinions, suggestions and comments provided by the different partners of the project are used to develop 2 scenarios for the business exploitation of the SHIPLYS tool and the financial forecast for each scenario.

4.4.1 Business model for commercialisation of the product

The selection of the optimal business model will support the establishment of a viable business which will commercialise the results from the SHIPLYS project, following productification/productisation projects and will disseminate the concept of services based engineering design tools.

Regarding the exploitation of the SHIPLYS products, the following options have been described to push forward the discussions on the subject:

Option 1: New established company - Partners jointly set up a company to be representative for SHIPLYS platform

Option 2: Ownership by one of the partners - Partners will choose a strategic partner to carry out the exploitation and business plan of the platform

Option 3: Exploitation by different partners separately – This model can confuse the market if there is cross-selling from different partners of the project

Option 4: SHIPLYS tool offered free of charge

Most of the partners – with some variations on the exploitation plan – agreed that one of the project's partners should take ownership of the SHIPLYS platform after the completion of the project.

The suggested model offers several advantages that support this decision:

- Only one partner will undertake the task to exploit the SHIPLYS tool. Any legal or financial obligation will be related only to this partner.
- The rest of the consortium will be covered from an initial contract providing details on IP issues and royalty fees.
- Avoids the complexity of creating a new company from the start.
- Makes the best use of existing capabilities and resources among partners involved.

On the other hand, the consortium needs to deal with the following subjects:

- Partners will need to agree from the beginning of the amount of money that will be satisfying for royalty purposes.
- Requires a workable model of responsibilities, profit and cost distribution.

4.4.2 The business model for future development

Before commercialisation, the software will require further adjustments in GUI, testing with users, testing in different environments and possible certification.

The business model for these future developments would involve efforts of project consortium members in getting additional funding.

Model for future development would build on the following necessary aspects:

- define key competencies required to make market-ready product.
- define consortium members providing the key competences both from the current project and possibly some new.
- prepare a proposal for funding from programmes that finance product commercialisation such as Fast Track Innovation, Eureka or SME Instrument.

4.5 Products/services offered

This section will describe the offerings provided by the SHIPLYS platform tools, services, support and training that ship designers or software developers would require.

Users will have the opportunity to access cutting-edge relevant software tools to support their business by producing ship designs to satisfy customer needs, production and legislative requirements through a software platform that offers a number of available software tools, in each stage of the design process to evaluate a variety of characteristics and life phases (structural, operation performance, production scheduling, etc.).

The offered products and services can take different forms to satisfy the needs and expectations of all the potential customers of the SHIPLYS platform. The provided product and services, addressed to both ship designers and software developers are presented next:

- The company exploiting the SHIPLYS products will provide a ready-to-use platform infrastructure accessible via a network where ship design users and software service providers can register on a per-project basis or per module used – if certain services are provided for free, registration will be free as well.
- A software product that enables design stakeholders to establish a privately-operated platform will also be provided. Design users will be able to purchase/rent/lease software that enables them to operate one or more "private" platform instances. The option to provide software services remotely exists, but access details need to be considered.
- Provision of a development integration toolkit has been considered for software services providers & vendors, and end-user organisations that want to integrate their in-house software. In this case, conditions include an option to get access to a free community edition if integration results are made available under similar free-use terms.

Providing platform integration tools and services to enable additional 3rd parties to join the platform could eventually lead to the design marketplace kind of model, which in turn could be an attracting feature for end-users.

4.6 Intellectual property strategy

All project partners are obligated to exploit the results. Exploitation arrangement may be executed in the form of licence agreements, anticipated in the PEDR and the Consortium Agreement.

A single point of distribution and management will provide efficiency and a consolidated market-facing presence enabling access to and thus sale (licensing) of the software on behalf of the software owning parties. IP would be retained by the respective companies for the relevant modules of the tool. A proposed software access model would be to provide time bounded rights/licencing to that software for the SHIPLYS package with royalties being paid to the software owning companies. This ensures IP (the software) is not handed over outright and preserves each company's right to develop their IP (subject to the terms of the licencing agreement). If desirable by the software owning party, terms of such a licencing agreement could warrant further development of the software in the SHIPLYS toolset for any module, by another member of the consortium (i.e. an open licence to the IP accessible by only those in the consortium).

4.7 Sales strategy

Regarding the pricing strategy to be adopted for the SHIPLYS business exploitation, several different opinions have been discussed. The partners agreed on the estimation of a fee per module used for the various tools provided in the SHIPLYS platform and a price list for different forms of the products and services, e.g. selling the SHIPLYS as a software suite to be installed by the end-user, having access via network, providing support and training for the platform services and the integration toolkit, etc.

The pricing strategy will be developed based on the competition in the market and the financial targets set by the administrator of the SHIPLYS tools and services. The income from the platform and the provided services will be used for:

- Maintenance of the SHIPLYS Platform.
- Provision of payment facility.
- Administrating payments to software tool providers.
- Developing and providing to software tool providers the software applications to link at the SHIPLYS Platform.

- Supporting the User administration page and managing User enquiries relating to this.
- Attracting additional Users.

As mentioned above, the sale prices for the related software have been already collected, and the targets are set by the partners involved in the exploitation of the SHIPLYS platform.

Also, the partners, based on their experience and knowledge of the market, have provided their estimations and comments on the sale prices of the SHIPLYS products and services as a whole and as individual provided tools. The most significant subjects that need to be discussed are:

- Definition of the royalties' fee (as a percentage or fixed) - this must be decided in advance.
- Develop a strategy on how to negotiate with 3rd party providers, which will develop the majority of the available tools.

4.7.1 Prices of individual software tools integrated into SHIPLYS platform

The following table contains the list of the tools integrated into the SHIPLYS platform and the accumulated information on access fees, market prices, support fees and training fees, as provided by the developers/owners partners:

Table 8: Price list for integrated software

	Access Fee	Market Price	Support Fee	Training Fee
AES SHIPYARD PRODUCTION SIMULATION		depends on project size and modules included	access fee would include support	on-site: 1350€/day + travel expenses
BMT RSET	2.000,00 €	2.500,00 €	500,00 €	2.000,00 €
CAFÉ depends on the number of licences; 1st year maintenance is free	1000 € / permanent (support not included)	5000 € / permanent (maintenance not included)	1.250,00 €	
CAFÉ price depends on the number of months needed	100 € / monthly (support included)	500 € / monthly (maintenance included)	0,00 €	
IST-tool	depends on the number of licences and months to be used	depends on modules included		to be defined
ShipLCA	Free	Free	200 € per year	on-site: 500 € + travel expenses online: 400 €

4.7.2 Defining the price of the SHIPLYS platform

The product developed within SHIPLYS project will be available on the market in 3 forms: a platform service, integration toolkit or a full suite combining all modules that are developed and integrated within SHIPLYS.

The following prices for the provided tools and services have been suggested:

- SHIPLYS PLATFORM SERVICES: per month or quarter, typical values would be 200-500€/month per some usage volume to be determined. This refers to a Service-level type contract ensuring a certain level of availability and support.
- SHIPLYS INTEGRATION TOOLKIT: Market Price 5.000,00 – 10.000,00 € / Support fee 22% p.a. / Training Fee (on-site coaching) 1450€/day + travel expenses. The integration toolkit will be available to 3rd party software vendors intending to integrate their software. A subscription model might also be considered.
- SOFTWARE INTEGRATION DEVELOPMENT: Price for the supported service will be depended on the complexity of the software to be integrated.
- FULL SUITE: 12.000,00 €. Pricing is for full tool suite (all modules) per year. Basis of estimation: Customer makes 10 bids/tender responses per year, saves 3 days labour per bid/tender response, 1 day of labour is 500 Euro. This allows for the customer to break even.
- SUPPORT AND MAINTENANCE: 3.000,00 - 4.000,00 €.
- TRAINING: 400,00 - 2.000,00 €.

4.8 Marketing strategy

The dissemination activities aim to create visibility and promote the exploitation of the concept and achievements of the SHIPLYS platform by establishing effective communication channels and appropriate liaisons with all relevant stakeholders. By creating awareness about the project outcomes and promoting their adoption, the company exploiting the platform will foster a culture of cooperation in the context of related services and applications. An impact assessment framework will measure the effectiveness of the impact related activities.

The main targets of the marketing strategy are to:

- Promote full visibility of the project's work and disseminate the results of the SHIPLYS project to all relevant stakeholders, in Europe and beyond.
- Establish liaisons with related companies and software developers as appropriate, to contribute to the creation of an ecosystem grouping active players in the domain ship design tools and applications.
- Create and maintain the platform's web site and appropriate communication channels to all external related communities/activities.
- Participate and organise specific events for increased and effective liaisons, dissemination of information and engagement of key stakeholders.
- Discover, build and reinforce partnerships with new technology and industry vendors to promote the exploitation of the project's platform.
- Define the impact assessment framework and conduct relevant activities to quantify the expected impacts.

SHIPLYS is aiming to reach out to the European SME shipyards and design offices, as well as other software developers. Hence, SHIPLYS primary marketing strategy will be targeting on these maritime and IT sectors.

Several state-of-the-art communication tools will be used to realise the communication strategy towards the relevant, targeted audiences or market stakeholders. These stakeholders have been identified during the development of the project. Each stakeholder will be approached with relevant and specific means of communication tools to achieve an optimal impact of the SHIPLYS tool.

Sales and promotion activities rely primarily on personal communication through organised customer meetings or presentations at specialised fairs. General information about the SHIPLYS products and its benefits will be provided by supplementary materials such as website, brochures, presentations and videos. The promotion strategy of the SHIPLYS products involves following tools and their relevant indicators for measuring results:

- A *website* will be established containing information on the mission and utilities of the SHIPLYS platform, the company exploiting the platform, abstract of the SHIPLYS project, events, contact details, online sales opportunity etc.
  - ✓ Indicators of success: views, clicks, return visits, number of sales
- A *newsletter* is used for fast announcement of news and relevant information. Several items are provided with a title and short abstract to invite the readers to click through towards the website.
  - ✓ Indicators of success: number of recipients
- *Social media* (Facebook, LinkedIn and Twitter) will be administrated for the announcement of news in real time mode. Also, new short messages will be promoted with link and reference to the website where more detailed information can be found.
  - ✓ Indicators of success: number of followers
- A *YouTube* trailer about the platform aiming at triggering potential users from the targeted market.
  - ✓ Indicators of success: number of views, shares
- *Educational communication* towards workers and researchers about the platform and its advantages though:
  - ✓ Invitations on educational workshops.
  - ✓ Demonstration of the SHIPLYS modules.
  - ✓ Indicators of success: number of attendances
- *Promotional Material*:
  - ✓ A banner with the logo of the SHIPLYS and the URL of the website.
  - ✓ Leaflets with the logo of the SHIPLYS and general info on the platform. If requested, the leaflets can be delivered in other EU languages.
  - ✓ Bags with the logo of the SHIPLYS and URL of the website.
  - ✓ Pencils with the logo of the SHIPLYS and URL of the website.
  - ✓ Additional promotional material with the logo of the SHIPLYS and URL of the website
  - ✓ Indicators of success: number of copies distributed
- *Exhibiting on specialized fairs:*
  - ✓ Arranging a stand to present a SHIPLYS product to the relevant audience
  - ✓ Organise several B2B meeting with the potential customers
  - ✓ Indicators of success: number of stand visitors, number of B2B meetings, number of sales leads

5 Financial Forecast

5.1 Methodology

The financial analysis has a threefold aim: the evaluation of financial profitability of the project, the determination of the appropriate (maximum) contribution from the funds, and finally, the assessment of project financial sustainability.

The financial analysis is performed for a reference period of n+14 years (n=1 being the first year of operation, namely 2020) by including both implementation and operations. Within this operating period, costs and benefits (project cash flows) for each year are determined and discounted on 2019 constant (real) prices, using the discounted cash flow method. The project's profitability is calculated using the basic indicators of financial decision making such as the financial Net Present Value (NPV), the Return on Investment (ROI), the Internal Rate of Return and the Payback Period of the investment, calculated with regards to the total investment cost (C).

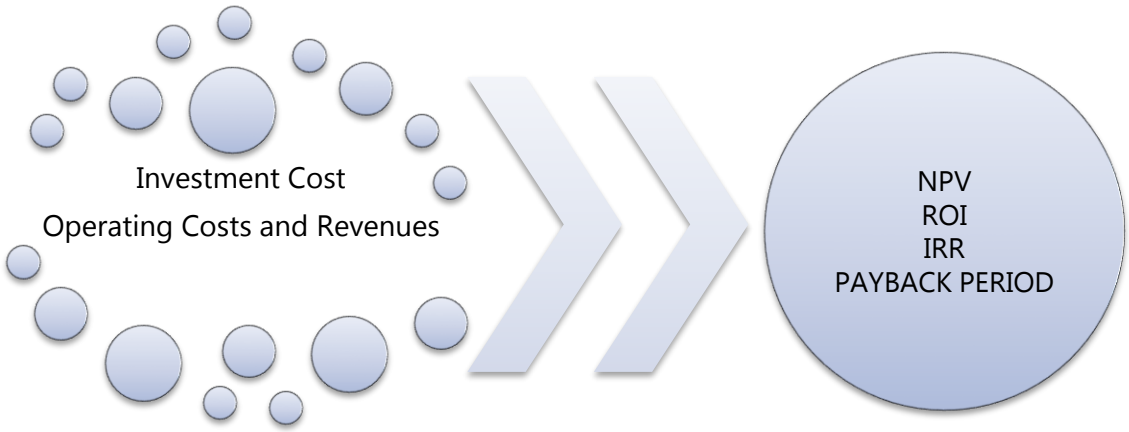


Figure 22: Methodology for the Financial Analysis

5.2 Key Assumptions

5.2.1 General Assumptions

For this analysis, the following key assumptions were adopted:

- All cash-flow generated by the proposed project during the observed period has been stated in Euros (EUR).
- An exchange rate of USD $ 1= EUR € 0.89[6], is used for the cost estimations provided in USD ($).
- The agreed period of observation included the development period and the operational period. The development period was defined as the period between 2016 and 2019. The operational period was defined as the period between 2020 and inclusive of 2034, i.e. 15 years. The agreed period of observation is according to the European Commission's recommendation [22] and included the economic exploitation of the SHIPLYS project, long enough to allow for all financial impacts of the proposed project to be viewed objectively.
- A financial discount rate of 4% was used according to the European Commission's [22] recommendation.
- The analysis was conducted using constant (real) prices, without inflation, reduced to the base year of the observed period.

[6] European Central Bank euro to US dollar (USD) reference exchange rate on 15/05/2019.

5.2.2 Capital Expenses

The SHIPLYS project has received 100% funding from the H2020 programme. Hence no initial investment has been taken by the partners of the project for the development of the SHIPLYS platform. In scenarios A and B the Cash Flow and Profit Margins will be presented for:

I. zero initial investment cost and
II. to present plausible financial and performance indicators, the maximum grant amount financed by the H2020 programme will be used as the initial investment cost for the development of the SHIPLYS platform for the period 2016-2019. The total grant amount of 6.144.150,00 € is analysed in the following table:

Table 9: SHIPLYS Budget Cost Analysis

COST CATEGORIES	GRANT AMOUNT
Direct personnel costs*	4.481.170,00 €
Other direct costs**	434.150,00 €
Indirect costs***	1.228.830,00 €
Total costs	6.144.150,00 €

**Direct personnel costs include a) employees (or equivalent), b) natural persons under direct contract c) seconded persons and d) personnel for providing access to research infrastructure.*

*** Other direct costs include a) travel expenses, b) equipment, c) other goods and services, d) costs of extensive research infrastructure.*

**** Indirect costs covered by the EU operating grant regulation. Estimated on a 25% flat rate of the direct costs.*

An additional scenario (Scenario C) has been developed based on assumptions and input from AES, as the main actor for the exploitation of the SHIPLYS platform and a deeper knowledge of the market that the product will be introduced, taking into account realistic estimations for the further development and business exploitation of the platform.

5.2.3 Required Revenues

The revenues are cash in-flows directly paid by users for the products and services provided by the company exploiting the SHIPLYS platform. The required revenues are the total amount from licence sales (estimated as price of a licence x number of licences sold), the income from maintenance services provided to users (estimated as price of maintenance x number of clients) and the income from sales of the SHIPLYS Integration Toolkit purchased by software solutions suppliers who will be interested to integrate their applications to the SHIPLYS platform.

The cost of a licence may vary depending on the number of modules/tools purchased by a client, while one client may purchase more than one licences. The price used for the estimations of the financial analysis is 12.000,00 €/per year for the full tool suite (all modules). An average for the purchase of the main modules provided by the SHIPLYS platform will be used as a 2nd scenario for the financial analysis.

Income from maintenance and customer services is estimated based on an average fixed price of 3.000,00 € for maintenance fees (this is based on the previous analysis for the sales strategy and the market analysis) multiplied by the number of licences sold each year. It is assumed that customers will purchase a maintenance contract along with the access to the SHIPLYS platform or will make use of the provided services at least once a year.

The cost of the SHIPLYS Integration Toolkit purchased by software solutions suppliers is set to 10.000,00€, including Support fees, training fees (on-site coaching) and travel expenses.

The number of licences sold/number of customers is estimated as a targeted share of the EU market for the successful exploitation of the SHIPLYS platform. The targeted market share is set at 10% of the total shipbuilding, ship repair and naval software solutions (as presented in Table 2 in chapter 3.1.4 and Table 5 in chapter 3.2 of the current deliverable).

5.2.4 Operating Expenses

The operating costs include all costs resulting from the operation of the company exploiting the SHIPLYS platform. The operating costs are divided between the fixed and variable operating costs. As part of this analysis and for the efficient exploitation of the project, the following assumptions on the cost estimations are used:

a) R&D costs (Software testing costs + training + IP protection): 10% / per year of the initial investment cost.

b) Intellectual Property Royalties: The intellectual property (IP) royalties that will be given to the software developers of the various modules/tools of the SHIPLYS platform have not yet been specified. For the analysis, a rate of 30% on last year's profits is used.

c) Sales and promotion cost: 10% of the annual estimated revenues.

d) Customer service costs: 50% of the total revenues from maintenance and customer services.

5.3 Performance indicators

5.3.1 NPV

Net present value (NPV) is a popular measure used to determine the present value of an investment by the discounted sum of all future cash flows. A profitable investment gives positive NPV at the end of the examined period (the higher the NPV value the most profitable the investment). The formula for estimating NPV is:

$$NPV = \sum_{i=1}^{n} \frac{C_i}{(1+r)^i} - C_{in}$$

Where C_i is the amount of the investment, r is the discount rate, n the total time of the investment and C_{in} the initial amount of the investment.

5.3.2 IRR

Using the formula for the NPV, one can estimate the Internal Rate of Return by assuming NPV's value equal to 0. The Internal Rate of Return (IRR) is used to measure and compare the profitability of an investment and shows the rate of return of the initial capital invested.

5.3.3 ROI (using a template from D2.2 "A report on templates for the business case and ROI analyses")

Return on investment (ROI) is a performance measure used to evaluate the efficiency of an investment. It measures the amount of return on an investment relative to the investment's cost. To calculate ROI, the benefit (or return) of an investment is divided by the cost of the investment, and the result is expressed as a percentage.

Calculation of ROI in the case of the business exploitation of the SHIPLYS platform requires the following data:

- Cost of manufacturing finalised and functional software (R&D + debugging + IP protection).
- Sale price of the software.

- Sale related costs (sales network).
- Market size (number of licences to be sold).
- Cost of royalties.
- Cost of additional staff for providing software training and customer support.

5.3.4 Payback Period

The payback period refers to the time required to recover the cost of an investment. The payback period is identified as the length of time when an investment reaches a break-even point (total revenues equals the total costs of an investment).

The desirability of an investment is directly related to its payback period since shorter payback time means more attractive investments.

5.3.5 Sensitivity Analysis

Sensitivity analysis provides a framework for evaluating new investments, reducing the possibility of undertaking a lousy investment. By changing the value of the specific parameter, in a given range, the respective values of NPV, IRR or Payback Period change accordingly giving better or more mediocre results. This, in turn, provides a 'safe' operating range for the company.

5.4 Results of the Financial Analysis

5.4.1 Scenario A – SHIPLYS offered as a full software suite

5.4.1.1 Cash Flow, Profit & Loss Forecast

Cash Flow, Profit & Loss Forecast for the 1st scenario have been estimated based on the following assumptions for various parameters of the financial analysis.

Table 10: Assumptions for Scenario A

Cash Flow	Parameters	Values
	Initial Investment Cost	I. 0,00 €
		II. 6.144.150,00 €
A1	**Price**	12.000,00 €
	Number Of Licences sold per year	122
	Total number of licences (in 15 years)	1835
A2	**Support / Maintenance**	3.000,00 €
	Total number Of Support Contracts (in 15 years)	1835
A3	**Integration Toolkit**	10.000,00 €
	Number Of Licences (in 15 years)	16
B1	**R&D Costs**	10% Of Initial Cost
B2	**Intellectual Property Royalties**	30% of last year's profits
B3	**Sales And Promotion Cost**	10% Of Revenues
B4	**Customer Service Costs**	50% Of Maintenance Income

I. zero initial investment cost

The results of the financial analysis are presented in the following table:

Table 11: Cash Flow, Profit & Loss Forecast

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A) REVENUES = A1 + A2 + A3	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00
A1) Licence sales income	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00
A2) Maintenance income	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00
A3) Integration Toolkit Purchases	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00
B) COST = B1 + B2 + B3 + B4	982.395,00	1.241.266,50	1.163.605,05	1.186.903,49	1.179.913,95	1.182.010,81	1.181.381,76	1.181.570,47	1.181.513,86	1.181.530,84	1.181.525,75	1.181.527,28	1.181.526,82	1.181.526,95	1.181.526,91
B1) R&D costs (Software testing costs + training)	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00
B2) Intellectual Property Royalties	0,00	258.871,50	181.210,05	204.508,49	197.518,95	199.615,81	198.986,76	199.175,47	199.118,86	199.135,84	199.130,75	199.132,28	199.131,82	199.131,95	199.131,91
B3) Sales and promotion cost	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00
B4) Customer service costs	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00
PROFIT = A - B	862.905,00	604.033,50	681.694,95	658.396,52	665.386,05	663.289,19	663.918,24	663.729,53	663.786,14	663.769,16	663.774,25	663.772,72	663.773,18	663.773,05	663.773,09
CUMULATIVE PROFIT	862.905,00	1.466.938,50	2.148.633,45	2.807.029,97	3.472.416,01	4.135.705,20	4.799.623,44	5.463.352,97	6.127.139,11	6.790.908,27	7.454.682,52	8.118.455,24	8.782.228,43	9.446.001,47	10.109.774,56
Present Value	829.716,35	558.462,93	606.024,33	562.800,10	546.898,83	524.207,08	504.523,30	484.980,66	466.367,34	448.418,66	431.175,10	414.590,49	398.644,97	383.312,39	368.569,63
Net Present Value	829.716,35	1.388.179,27	1.994.203,60	2.557.003,70	3.103.902,53	3.628.109,61	4.132.632,91	4.617.613,57	5.083.980,91	5.532.399,57	5.963.574,67	6.378.165,15	6.776.810,12	7.160.122,52	7.528.692,15

Using the above financial results a Sensitivity Analysis of the NPV has been performed for different sale prices of the SHIPLYS platform and different achieved market share as presented in the following table and chart:

Table 12: Sensitivity Analysis of NPV

Sensitivity Analysis NPV	Market Share				
Price	5%	8%	10%	12%	15%
10.000,00 €	123.674,35 €	3.414.275,70 €	5.608.009,93 €	7.801.744,17 €	11.092.345,52 €
11.000,00 €	603.844,90 €	4.182.548,58 €	6.568.351,04 €	8.954.153,50 €	12.532.857,18 €
12.000,00 €	1.084.015,46 €	4.950.821,47 €	7.528.692,15 €	10.106.562,83 €	13.973.368,85 €
13.000,00 €	1.564.186,01 €	5.719.094,36 €	8.489.033,26 €	11.258.972,16 €	15.413.880,51 €
14.000,00 €	2.044.356,56 €	6.487.367,25 €	9.449.374,37 €	12.411.381,49 €	16.854.392,17 €
15.000,00 €	2.524.527,12 €	7.255.640,13 €	10.409.715,48 €	13.563.790,82 €	18.294.903,84 €

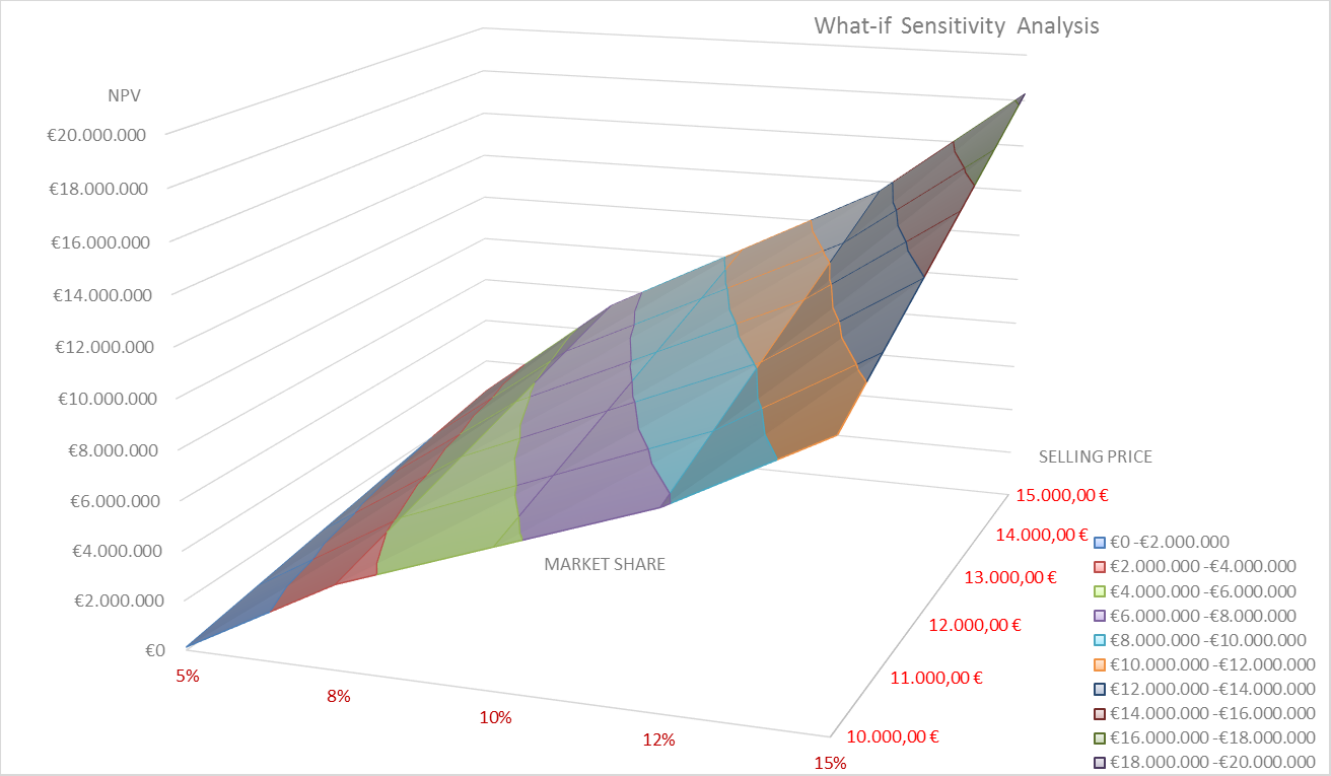


Figure 23: Sensitivity Analysis on NPV for different sale prices and market share

II. Initial investment cost: the total grant amount of 6.144.150,00 €

The results of the financial analysis considering an initial investment cost the total EU grant amount are presented in Table 13:

Table 13: Cash Flow, Profit & Loss Forecast

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A) REVENUES = A1 + A2 + A3	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00
A1) Licence sales income	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00
A2) Maintenance income	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00
A3) Integration Toolkit Purchases	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00
B) COST = B1 + B2 + B3 + B4	982.395,00	1.241.266,50	1.163.605,05	1.186.903,49	1.179.913,95	1.182.010,81	1.181.381,76	1.181.570,47	1.181.513,86	1.181.530,84	1.181.525,75	1.181.527,28	1.181.526,82	1.181.526,95	1.181.526,91
B1) R&D costs (Software testing costs + training)	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00
B2) Intellectual Property Royalties	0,00	258.871,50	181.210,05	204.508,49	197.518,95	199.615,81	198.986,76	199.175,47	199.118,86	199.135,84	199.130,75	199.132,28	199.131,82	199.131,95	199.131,91
B3) Sales and promotion cost	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00
B4) Customer service costs	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00
PROFIT = A - B	862.905,00	604.033,50	681.694,95	658.396,52	665.386,05	663.289,19	663.918,24	663.729,53	663.786,14	663.769,16	663.774,25	663.772,72	663.773,18	663.773,05	663.773,09
CUMULATIVE PROFIT	862.905,00	1.466.938,50	2.148.633,45	2.807.029,97	3.472.416,01	4.135.705,20	4.799.623,44	5.463.352,97	6.127.139,11	6.790.908,27	7.454.682,52	8.118.455,24	8.782.228,43	9.446.001,47	10.109.774,56
Present Value	829.716,35	558.462,93	606.024,33	562.800,10	546.898,83	524.207,08	504.523,30	484.980,66	466.367,34	448.418,66	431.175,10	414.590,49	398.644,97	383.312,39	368.569,63
Net Present Value	-5.314.433,65	-4.755.970,73	-4.149.946,40	-3.587.146,30	-3.040.247,47	-2.516.040,39	-2.011.517,09	-1.526.536,43	-1.060.169,09	-611.750,43	-180.575,33	234.015,15	632.660,12	1.015.972,52	1.384.542,15

The performance indicators derived from the above financial forecast are given in Table 14:

Table 14: Evaluation of the financial forecast

Performance indicators	Results
NPV	1.384.542,15 €
ROI	22,53%
IRR	7,12%
PAYBACK PERIOD	10,52 years

Using the above financial results a Sensitivity Analysis of the NPV, IRR and Payback Period indicators has been performed for different sale prices of the SHIPLYS platform and different achieved market share as presented in the following tables and charts:

Table 15: Sensitivity Analysis of NPV

Sensitivity Analysis NPV	Market Share				
Price	5%	8%	10%	12%	15%
10.000,00 €	-6.020.475,65 €	-2.729.874,30 €	-536.140,07 €	1.657.594,17 €	4.948.195,52 €
11.000,00 €	-5.540.305,10 €	-1.961.601,42 €	424.201,04 €	2.810.003,50 €	6.388.707,18 €
12.000,00 €	-5.060.134,54 €	-1.193.328,53 €	1.384.542,15 €	3.962.412,83 €	7.829.218,85 €
13.000,00 €	-4.579.963,99 €	-425.055,64 €	2.344.883,26 €	5.114.822,16 €	9.269.730,51 €
14.000,00 €	-4.099.793,44 €	343.217,25 €	3.305.224,37 €	6.267.231,49 €	10.710.242,17 €
15.000,00 €	-3.619.622,88 €	1.111.490,13 €	4.265.565,48 €	7.419.640,82 €	12.150.753,84 €

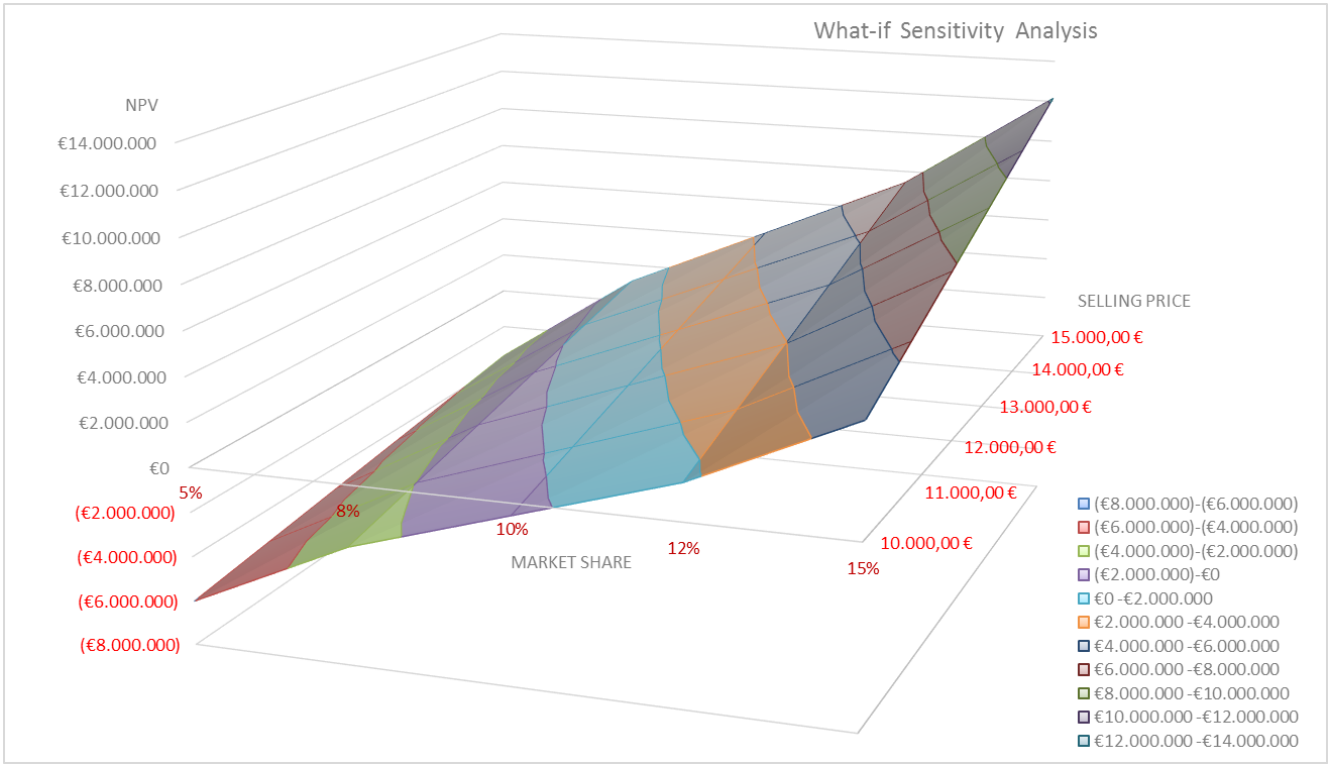


Figure 24: Sensitivity Analysis on NPV for different sale prices and market share

Table 16: Sensitivity Analysis of IRR

Sensitivity Analysis IRR	Market Share				
Price	5%	8%	10%	12%	15%
10.000,00 €	-	-3,49%	2,70%	7,71%	14,22%
11.000,00 €	-18,77%	-1,12%	4,99%	10,09%	16,87%
12.000,00 €	-14,33%	1,02%	7,12%	12,35%	19,44%
13.000,00 €	-11,24%	2,97%	9,14%	14,53%	21,95%
14.000,00 €	-8,79%	4,80%	11,07%	16,65%	24,42%
15.000,00 €	-6,72%	6,53%	12,93%	18,71%	26,86%

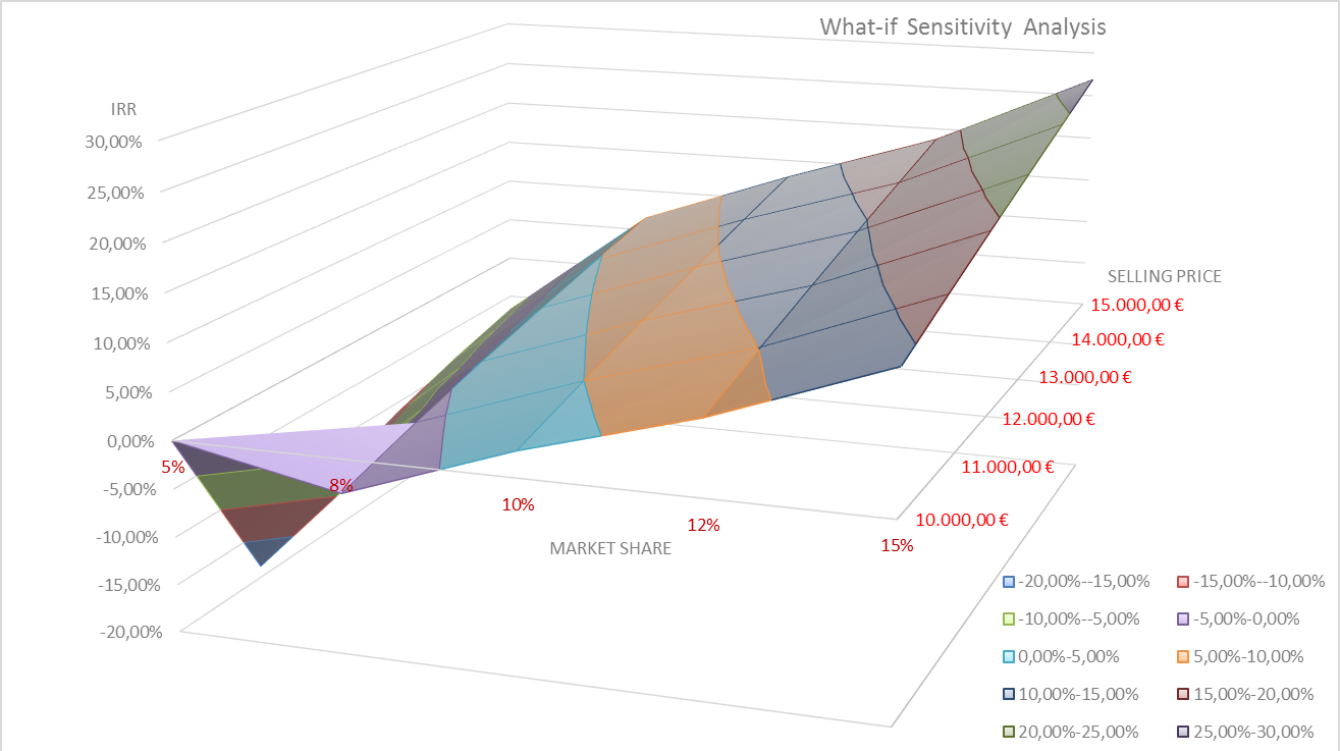


Figure 25: Sensitivity Analysis on IRR for different sale prices and market share

Table 17: Sensitivity Analysis on Payback Period (years)

Sensitivity Analysis PP	Market Share			
Price	8%	10%	12%	15%
10.000,00 €	23,77	14,28	10,13	6,98
11.000,00 €	19,32	12,12	8,76	6,12
12.000,00 €	16,24	10,52	7,71	5,44
13.000,00 €	14,00	9,27	6,87	3,62
14.000,00 €	12,28	8,28	6,19	3,31
15.000,00 €	10,93	7,47	5,62	3,05

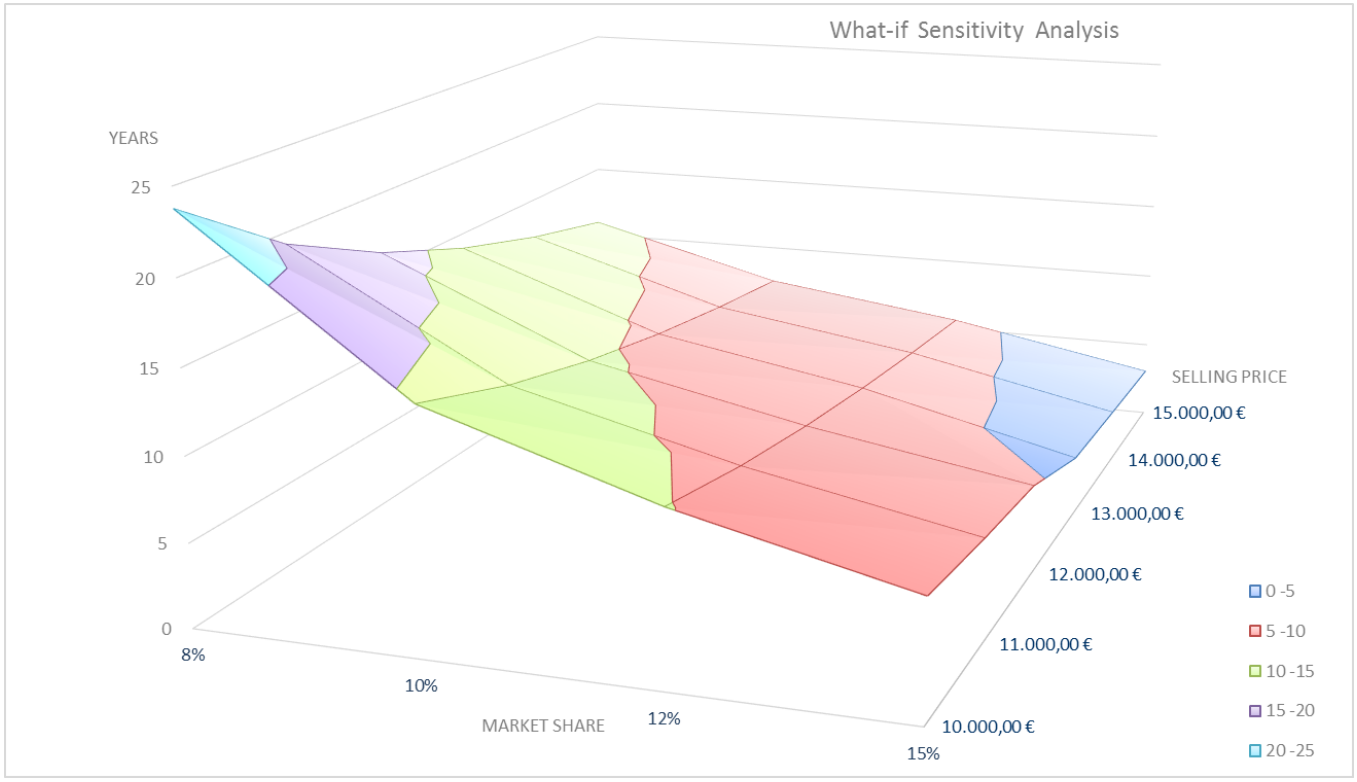


Figure 26: Sensitivity Analysis on Payback Period for different sale prices and market share

5.4.1.2 Scenario A assessment

Using a fixed price to purchase a full suite of the SHIPLYS platform offers significant profit margins even in the case of taking in consideration the EU grant amount of the SHIPLYS project as the initial investment for its development. Using a rather moderate price, the financial results are satisfactory while improving the market share target, long-term financial results are also improved significantly.

5.4.2 Scenario B – Integrated Modules offered separately

5.4.2.1 Cash Flow, Profit & Loss Forecast

As in the previous scenario, the Cash Flow and Profit Margins are estimated for:

I. zero initial investment cost and
II. considering an initial investment cost the total EU grant amount.

The average price for purchasing different tools of the SHIPLYS platform, based on the information presented in Table 8, is set in 2.000,00 € per year. From the summary of the SHIPLYS questionnaire's results in Table 7, it is evident that each client will require more than one licence to complete an initial ship design project (and up to 18 different software tools). For the financial analysis, it is assumed that an average of 9 licences per client will be purchased.

Furthermore, the use of various tools provided by different software developers will require additional fees for support and maintenance that will raise the cost of these services. The price of Support Contract is set at 4.000,00 € per year.

Cash Flow, Profit & Loss Forecast for the 2nd scenario have been estimated based on those above and the following assumptions for the various parameters of the financial analysis.

Table 18: Assumptions for Scenario B

Cash Flow	Parameters	Values
	Initial Investment Cost	I. 0,00 €
		II. 6.144.150,00 €
A1	**Average Module Price / year**	2.000,00 €
	Number Of Licences per client / year	9
	Market Share (over 15 years)	10%
	Number of clients (over 15 years)	1835
A2	**Support / Maintenance Price**	4.000,00 €
	Number Of Support Contracts	1835
A3	**Integration Toolkit**	10.000,00 €
	Number Of Licences	16
B1	**R&D Costs**	10% Of Initial Cost
B2	**Intellectual Property Royalties**	30% of last year's profits
B3	**Sales And Promotion Cost**	10% Of Revenues
B4	**Customer Service Costs**	50% Of Maintenance Income

I. zero initial investment cost

The results of the financial analysis when considering zero initial cost are presented in Table 19:

Table 19: Cash Flow, Profit & Loss Forecast

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A) REVENUES = A1 + A2 + A3	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00
A1) Licence sales income	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00
A2) Maintenance income	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00
A3) Integration Toolkit Purchases	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00
B) COST = B1 + B2 + B3 + B4	1.129.155,00	1.600.828,50	1.459.326,45	1.501.777,07	1.489.041,88	1.492.862,44	1.491.716,27	1.492.060,12	1.491.956,96	1.491.987,91	1.491.978,63	1.491.981,41	1.491.980,58	1.491.980,83	1.491.980,75
B1) R&D costs (Software testing costs + training)	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00
B2) Intellectual Property Royalties	0,00	471.673,50	330.171,45	372.622,07	359.886,88	363.707,44	362.561,27	362.905,12	362.801,96	362.832,91	362.823,63	362.826,41	362.825,58	362.825,83	362.825,75
B3) Sales and promotion cost	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00
B4) Customer service costs	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00
PROFIT = A - B	1.572.245,00	1.100.571,50	1.242.073,55	1.199.622,94	1.212.358,12	1.208.537,56	1.209.683,73	1.209.339,88	1.209.443,04	1.209.412,09	1.209.421,37	1.209.418,59	1.209.419,42	1.209.419,17	1.209.419,25
CUMULATIVE PROFIT	1.572.245,00	2.672.816,50	3.914.890,05	5.114.512,99	6.326.871,10	7.535.408,67	8.745.092,40	9.954.432,28	1.163.875,32	12.373.287,41	13.582.708,78	14.792.127,37	16.001.546,79	17.210.965,96	18.420.385,21
Present Value	1.511.774,04	1.017.540,22	1.104.198,86	1.025.442,71	996.470,00	955.124,79	919.260,22	883.652,81	849.738,63	817.035,47	785.617,06	755.399,28	726.345,97	698.409,44	671.547,58
Net Present Value	1.511.774,04	2.529.314,26	3.633.513,12	4.658.955,83	5.655.425,83	6.610.550,63	7.529.810,84	8.413.463,65	9.263.202,28	10.080.237,75	10.865.854,82	11.621.254,10	12.347.600,06	13.046.009,50	13.717.557,08

Using the above financial results a Sensitivity Analysis of the NPV has been performed for different sale prices of the SHIPLYS platform and different achieved market share as presented in the following table and chart:

Table 20: Sensitivity Analysis of NPV

Sensitivity Analysis NPV	Market Share				
Price	5%	8%	10%	12%	15%
1.000,00 €	-143.087,07 €	2.987.457,43 €	5.074.487,09 €	7.161.516,76 €	10.292.061,26 €
1.500,00 €	2.017.680,42 €	6.444.685,42 €	9.396.022,09 €	12.347.358,75 €	16.774.363,75 €
2.000,00 €	4.178.447,92 €	9.901.913,41 €	13.717.557,08 €	17.533.200,74 €	23.256.666,24 €
2.500,00 €	6.339.215,41 €	13.359.141,41 €	18.039.092,07 €	22.719.042,73 €	29.738.968,72 €
3.000,00 €	8.499.982,91 €	16.816.369,40 €	22.360.627,06 €	27.904.884,72 €	36.221.271,21 €
3.500,00 €	10.660.750,41 €	20.273.597,39 €	26.682.162,05 €	33.090.726,71 €	42.703.573,70 €

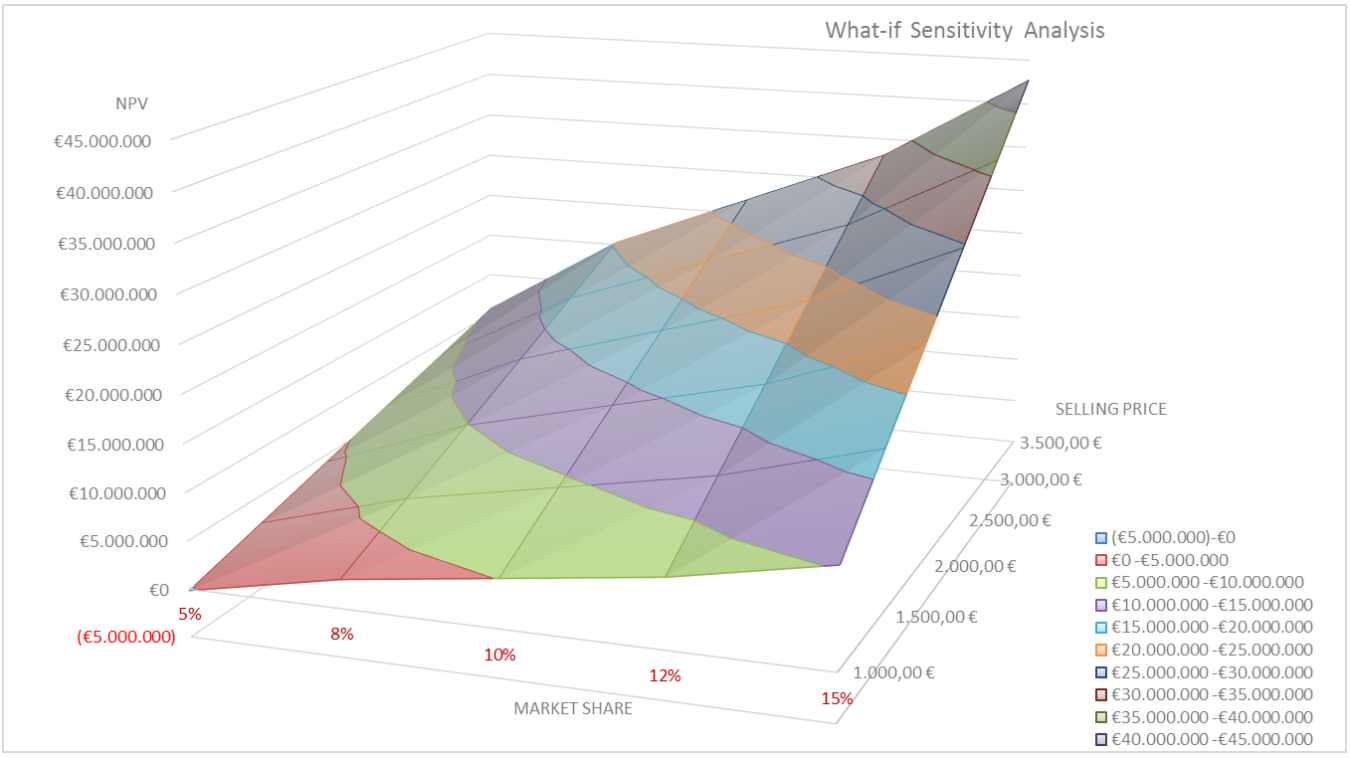


Figure 27: Sensitivity Analysis on NPV for different sale prices and market share

II. Initial investment cost: the total grant amount of 6.144.150,00 €

The results of the financial analysis considering an initial investment cost the total EU grant amount are presented in the next table:

Table 21: Cash Flow, Profit & Loss Forecast

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A) REVENUES = A1 + A2 + A3	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00	2.701.400,00
A1) Licence sales income	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00	2.201.400,00
A2) Maintenance income	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00	489.200,00
A3) Integration Toolkit Purchases	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00
B) COST = B1 + B2 + B3 + B4	1.129.155,00	1.600.828,50	1.459.326,45	1.501.777,07	1.489.041,88	1.492.862,44	1.491.716,27	1.492.060,12	1.491.956,96	1.491.987,91	1.491.978,63	1.491.981,41	1.491.980,58	1.491.980,83	1.491.980,75
B1) R&D costs (Software testing costs + training)	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00	614.415,00
B2) Intellectual Property Royalties	0,00	471.673,50	330.171,45	372.622,07	359.886,88	363.707,44	362.561,27	362.905,12	362.801,96	362.832,91	362.823,63	362.826,41	362.825,58	362.825,83	362.825,75
B3) Sales and promotion cost	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00	270.140,00
B4) Customer service costs	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00	244.600,00
PROFIT = A - B	1.572.245,00	1.100.571,50	1.242.073,55	1.199.622,94	1.212.358,12	1.208.537,56	1.209.683,73	1.209.339,88	1.209.443,04	1.209.412,09	1.209.421,37	1.209.418,59	1.209.419,42	1.209.419,17	1.209.419,25
CUMULATIVE PROFIT	1.572.245,00	2.672.816,50	3.914.890,05	5.114.512,99	6.326.871,10	7.535.408,67	8.745.092,40	9.954.432,28	1.163.875,32	12.373.287,41	13.582.708,78	14.792.127,37	16.001.546,79	17.210.965,96	18.420.385,21
Present Value	1.511.774,04	1.017.540,22	1.104.198,86	1.025.442,71	996.470,00	955.124,79	919.260,22	883.652,81	849.738,63	817.035,47	785.617,06	755.399,28	726.345,97	698.409,44	671.547,58
Net Present Value	-4.632.375,96	-3.614.835,74	-2.510.636,88	-1.485.194,17	-488.724,17	466.400,63	1.385.660,84	2.269.313,65	3.119.052,28	3.936.087,75	4.721.704,82	5.477.104,10	6.203.450,06	6.901.859,50	7.573.407,08

The performance indicators derived from the above financial forecast are given in Table 22:

Table 22: Evaluation of the financial forecast

Performance indicators	Results
NPV	7.573.407,08 €
ROI	123,26%
IRR	18,99%
PAYBACK PERIOD	5,55 years

Using the above financial results a Sensitivity Analysis of the NPV, IRR and Payback Period indicators has been performed for different sale prices of the SHIPLYS platform and different achieved market share as presented in the following tables and charts:

Table 23: Sensitivity Analysis of NPV

Sensitivity Analysis NPV	Market Share				
Price	5%	8%	10%	12%	15%
1.000,00 €	-6.287.237,07 €	-3.156.692,57 €	-1.069.662,91 €	1.017.366,76 €	4.147.911,26 €
1.500,00 €	-4.126.469,58 €	300.535,42 €	3.251.872,09 €	6.203.208,75 €	10.630.213,75 €
2.000,00 €	-1.965.702,08 €	3.757.763,41 €	7.573.407,08 €	11.389.050,74 €	17.112.516,24 €
2.500,00 €	195.065,41 €	7.214.991,41 €	11.894.942,07 €	16.574.892,73 €	23.594.818,72 €
3.000,00 €	2.355.832,91 €	10.672.219,40 €	16.216.477,06 €	21.760.734,72 €	30.077.121,21 €
3.500,00 €	4.516.600,41 €	14.129.447,39 €	20.538.012,05 €	26.946.576,71 €	36.559.423,70 €

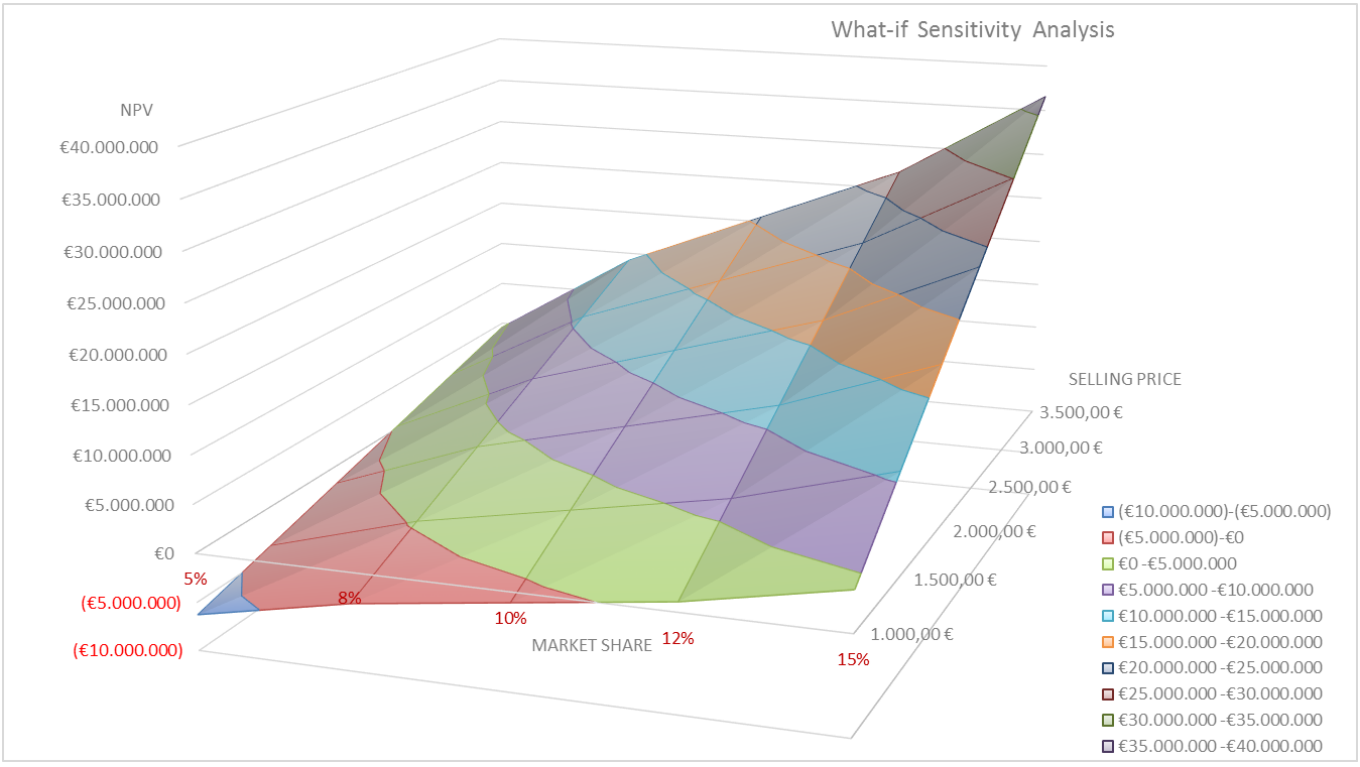


Figure 28: Sensitivity Analysis on NPV for different sale prices and market share

Table 24: Sensitivity Analysis of IRR

Sensitivity Analysis IRR	Market Share				
Price	5%	8%	10%	12%	15%
1.000,00 €	-	-4,96%	1,34%	6,32%	12,71%
1.500,00 €	-8,91%	4,70%	10,97%	16,53%	24,28%
2.000,00 €	-1,13%	11,96%	18,99%	25,57%	35,14%
2.500,00 €	4,46%	18,35%	26,43%	34,25%	45,86%
3.000,00 €	9,16%	24,36%	33,65%	42,83%	56,65%
3.500,00 €	13,41%	30,18%	40,81%	51,43%	67,54%

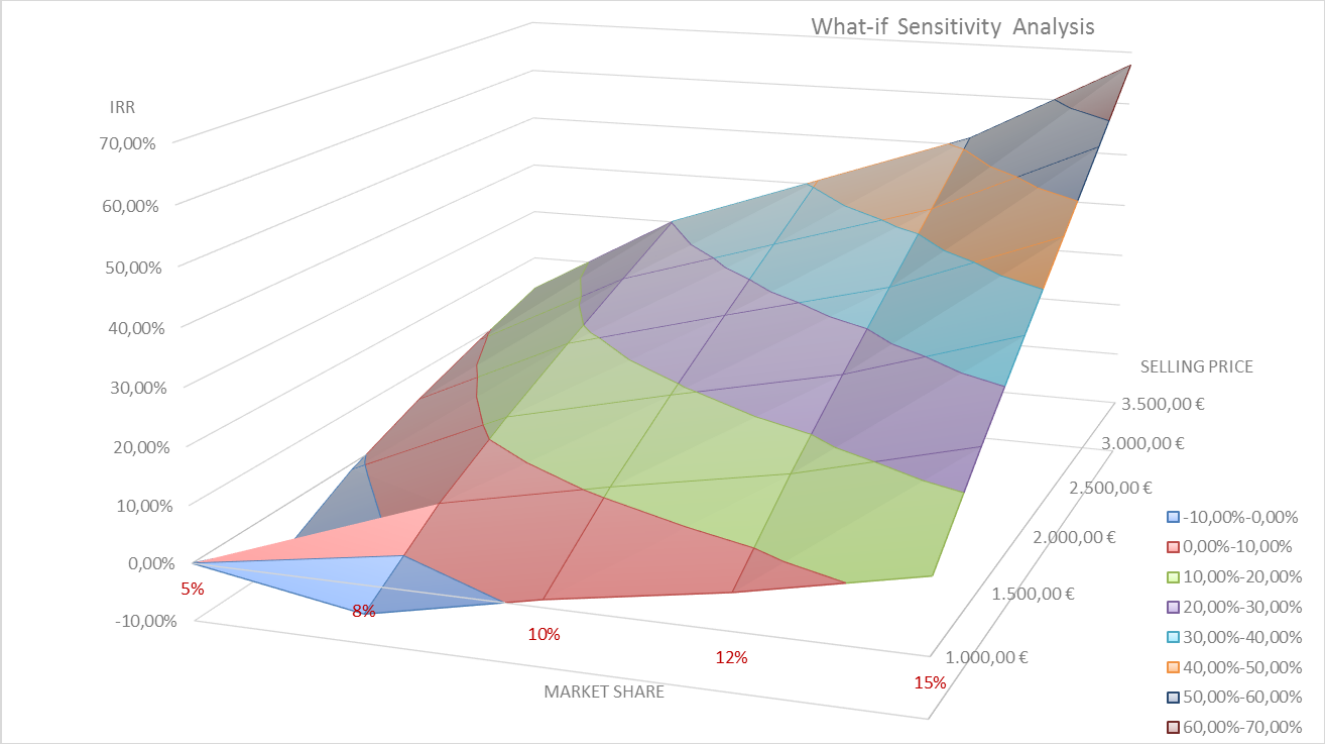


Figure 29: Sensitivity Analysis on IRR for different sale prices and market share

Table 25: Sensitivity Analysis on Payback Period (years)

Sensitivity Analysis PP	Market Share			
Price	8%	10%	12%	15%
1.000,00 €	27,24	15,84	11,08	7,56
1.500,00 €	12,37	8,33	6,22	3,32
2.000,00 €	7,88	5,55	3,18	2,40
2.500,00 €	5,71	3,09	2,45	1,87
3.000,00 €	3,32	2,49	2,00	1,54
3.500,00 €	2,75	2,09	1,68	1,31

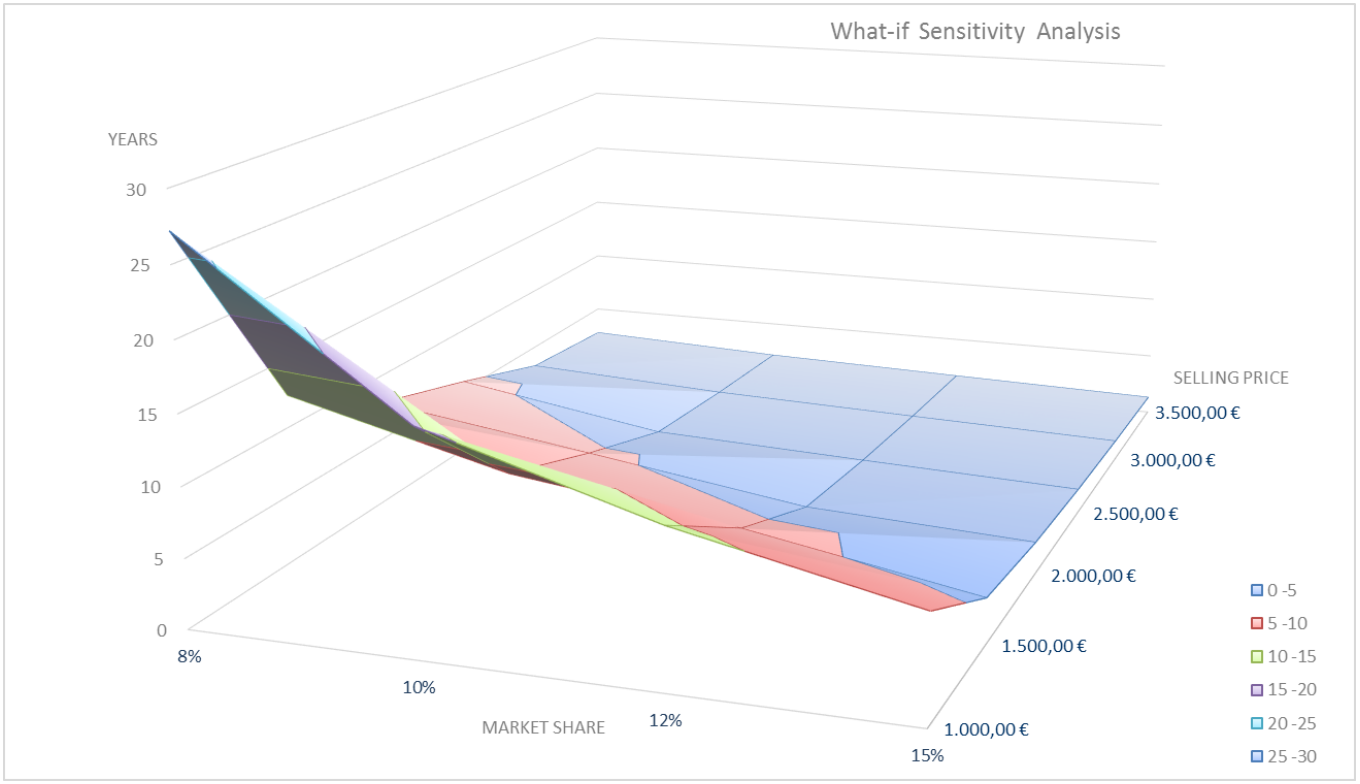


Figure 30: Sensitivity Analysis on Payback Period for different sale prices and market share

5.4.2.2 Scenario B assessment

Using an indicative average price for purchasing different tools of the SHIPLYS platform, can also provide significant profit margins even in the case of taking in consideration the EU grant amount of the SHIPLYS project as the initial investment for its development.

The financial indicators present a more profitable scenario compared to scenario A, since the use of different prices for different tools of the SHIPLYS platform may offer an advantage in achieving a more successful market entry and a larger market share, by offering more flexible products and services to potential customers, improving long-term financial results from the commercialisation of the SHIPLYS platform.

5.4.3 Scenario C – AES further productification of the SHIPLYS platform

5.4.3.1 Cash Flow, Profit & Loss Forecast

The further development, productification and business exploitation of the SHIPLYS platform, will require additional expenses the first years after the end of the SHIPLYS project and the EU funding. Atlantec Enterprise Solutions (AES) has provided, based on their experience and deeper knowledge of the ship design software market, a general estimation of the additional CAPEX required during the first 2 years of the SHIPLYS platform commercialisation.

The successful introduction of the product into the market will require support from a small number of end-user partners (which will contribute partially to fund the additional expenses of the first 2 years of the business exploitation) and potentially additional associated companies. The SHIPLYS project will be used to establish a small number (2-5) of reference installations to facilitate the effective implementation of the developed business strategy.

The additional investment cost is estimated at approximately 2.500.000 € as presented in the next table:

Table 26: Scenario B – Productification budget

Costs	Budget
Administrative/Personnel etc.	2.125.000,00 €
Sales & Marketing For Transition Period (over 2 years)	250.000,00 €
Hardware & Software	100.000,00 €
Travel Expenses	25.000,00 €
Total	2.500.000,00 €

For the estimation of future Revenues and Costs, the same assumptions as in scenario A (Table 10) will be used.
Regarding the examined second phase of the product's development and productification, an additional public source of funding (e.g. FTI, SMEI etc.) could be pursued in order to move the technological readiness of the SHIPLYS platform into a TRL level of 8 or 9 or a bank loan could be considered.
For the purposes of the financial analysis two different cases are examined:

I. Project funded 70% (1.750.000,00 €)
II. Receive bank loan for the same amount

I. Project funded 70% by an EU funding programme

As the initial investment cost, the amount of 750.000,00 € will be used for the purposes of this analysis. We presume that the remaining 1.750.000,00 € are secured by a European funding tool for SME's and technological innovation.
The results of the financial analysis are presented in Table 27.

Table 27: Cash Flow, Profit & Loss Forecast

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A) REVENUES = A1 + A2 + A3	0,00	0,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00
A1) Licence sales income	0,00	0,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00
A2) Maintenance income	0,00	0,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00
A3) Integration Toolkit Purchases	0,00	0,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00
B) COST = B1 + B2 + B3 + B4	200.000,00	200.000,00	442.980,00	863.676,00	737.467,20	775.329,84	763.971,05	767.378,69	766.356,39	766.663,08	766.571,08	766.598,68	766.590,40	766.592,88	766.592,14
B1) R&D costs (Software testing costs + training)	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00	75.000,00
B2) Intellectual Property Royalties	0,00	0,00	0,00	420.696,00	294.487,20	332.349,84	320.991,05	324.398,69	323.376,39	323.683,08	323.591,08	323.618,68	323.610,40	323.612,88	323.612,14
B3) Sales and promotion cost	125.000,00	125.000,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00
B4) Customer service costs	0,00	0,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00
PROFIT = A - B	-200.000,00	-200.000,00	1.402.320,00	981.624,00	1.107.832,80	1.069.970,16	1.081.328,95	1.077.921,31	1.078.943,61	1.078.636,92	1.078.728,92	1.078.701,32	1.078.709,60	1.078.707,12	1.078.707,86
CUMULATIVE PROFIT	-200.000,00	-400.000,00	1.002.320,00	1.983.944,00	3.091.776,80	4.161.746,96	5.243.075,91	6.320.997,23	7.399.940,83	8.478.577,75	9.557.306,67	10.636.008,00	11.714.717,60	12.793.424,72	13.872.132,58
Present Value	-192.307,69	-184.911,24	1.246.657,37	839.096,31	910.557,81	845.612,96	821.721,13	787.626,55	758.051,47	728.688,45	700.721,74	673.753,66	647.845,03	622.926,48	598.968,19
Net Present Value	-942.307,69	-1.127.218,93	119.438,44	958.534,75	1.869.092,56	2.714.705,52	3.536.426,65	4.324.053,19	5.082.104,66	5.810.793,11	6.511.514,85	7.185.268,52	7.833.113,55	8.456.040,03	9.055.008,22

The performance indicators derived from the above financial forecast are given in Table 28:

Table 28: Evaluation of the financial forecast

Performance indicators	Results
NPV	9.055.008,22 €
ROI	1207,33%
IRR	52,10%
PAYBACK PERIOD	2,90 years

Using the above financial results a Sensitivity Analysis of the NPV and IRR indicators has been performed for different sale prices of the SHIPLYS platform and different achieved market share as presented in the following tables and charts:

Table 29: Sensitivity Analysis of NPV

Sensitivity Analysis NPV	Market Share				
Price	5%	8%	10%	12%	15%
10.000,00 €	2.892.390,80 €	5.630.901,06 €	7.456.574,56 €	9.282.248,07 €	12.020.758,32 €
11.000,00 €	3.291.999,22 €	6.270.274,52 €	8.255.791,39 €	10.241.308,26 €	13.219.583,56 €
12.000,00 €	3.691.607,63 €	6.909.647,99 €	9.055.008,22 €	11.200.368,45 €	14.418.408,81 €
13.000,00 €	4.091.216,05 €	7.549.021,45 €	9.854.225,05 €	12.159.428,65 €	15.617.234,05 €
14.000,00 €	4.490.824,46 €	8.188.394,91 €	10.653.441,88 €	13.118.488,84 €	16.816.059,29 €
15.000,00 €	4.890.432,88 €	8.827.768,37 €	11.452.658,70 €	14.077.549,04 €	18.014.884,53 €

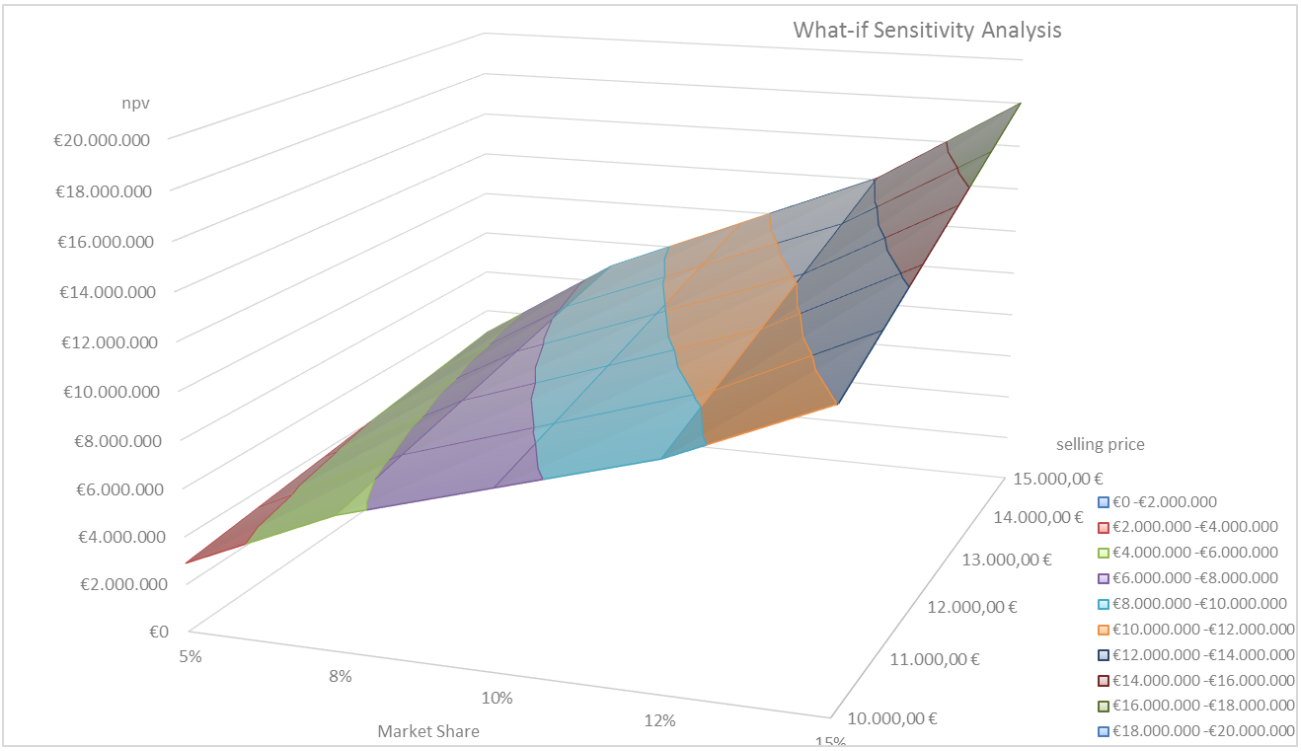


Figure 31: Sensitivity Analysis on NPV for different sale prices and market share

Table 30: Sensitivity Analysis of IRR

Sensitivity Analysis IRR	Market Share				
Price	5%	8%	10%	12%	15%
10.000,00 €	25,94%	39,15%	46,41%	52,87%	61,49%
11.000,00 €	28,12%	41,80%	49,32%	56,02%	64,95%
12.000,00 €	30,19%	44,33%	52,10%	59,02%	68,25%
13.000,00 €	32,18%	46,75%	54,76%	61,90%	71,40%
14.000,00 €	34,08%	49,08%	57,33%	64,66%	74,43%
15.000,00 €	35,92%	51,32%	59,79%	67,33%	77,35%

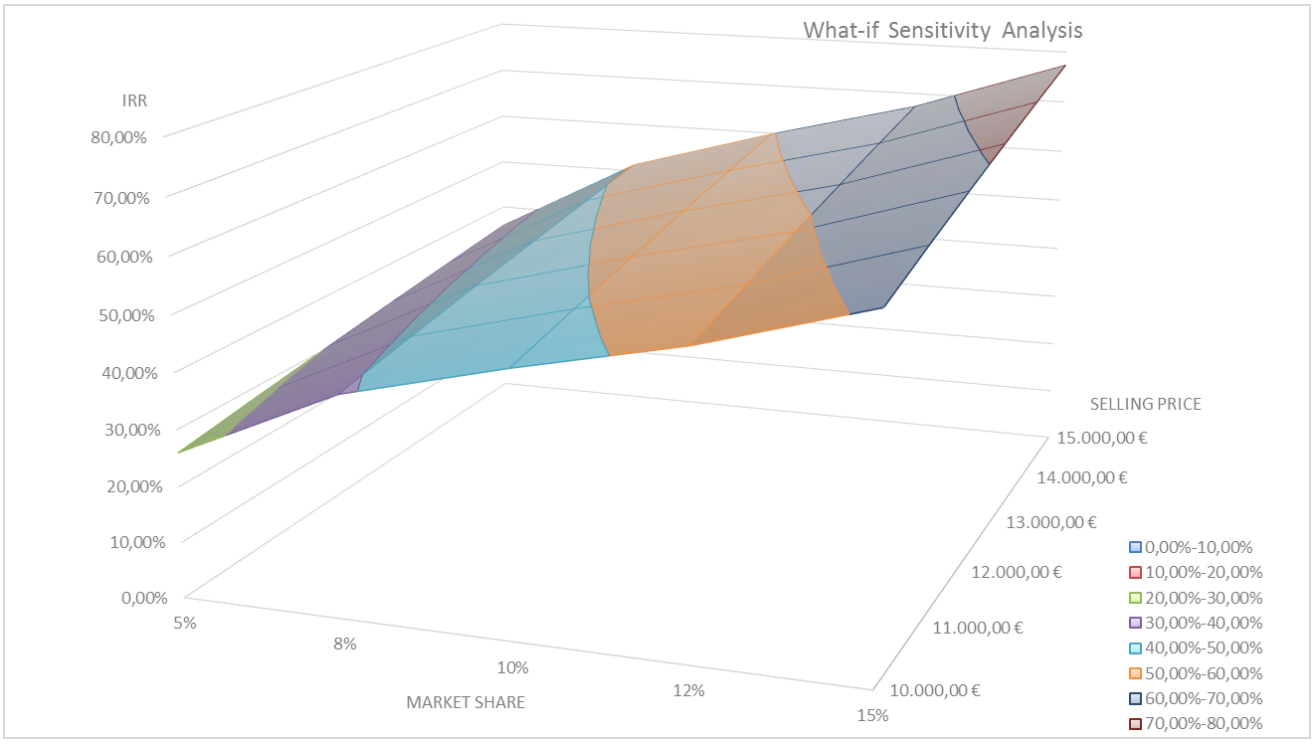


Figure 32: Sensitivity Analysis on IRR for different sale prices and market share

II. Bank loan 70% of the required investment cost

For the estimated additional investment of 2.500.000 €, a bank loan of 1.750.000 € will be secured to cover any financial gap for the exploitation of the SHIPLYS platform. Own funds (750.000 €) will be covered by end-user partners supporting the commercial exploitation of the developed product. An interest rate of 4% [22] will be used to estimate the loan repayment. The repayments will begin in Year 3 and will be extended over a period of 8 years (Year 10 total repayment).

The results of the financial analysis for this scenario are presented in the next table.

Table 31: Cash Flow, Profit & Loss Forecast

Years	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A) REVENUES = A1 + A2 + A3	0,00	0,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00	1.845.300,00
A1) Licence sales income	0,00	0,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00	1.467.600,00
A2) Maintenance income	0,00	0,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00	366.900,00
A3) Integration Toolkit Purchases	0,00	0,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00	10.800,00
B) COST =B1+ B2+B3+B4+B5	375.000,00	375.000,00	867.906,64	1.161.124,65	1.073.159,25	1.099.548,87	1.091.631,98	1.094.007,05	1.093.294,53	1.093.508,28	843.517,52	918.514,75	896.015,58	902.765,33	900.740,40
B1) R&D costs (Software testing costs + training)	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00	250.000,00
B2) Intellectual Property Royalties	0,00	0,00	0,00	293.218,01	205.252,61	231.642,23	223.725,34	226.100,41	225.387,89	225.601,64	225.537,52	300.534,75	278.035,58	284.785,33	282.760,40
B3) Sales and promotion cost	125.000,00	125.000,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00	184.530,00
B4) Customer service costs	0,00	0,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00	183.450,00
B5) Loan payments	0,00	0,00	249.926,64	249.926,64	249.926,64	249.926,64	249.926,64	249.926,64	249.926,64	249.926,64	0,00	0,00	0,00	0,00	0,00
PROFIT = A - B	-375.000,00	-375.000,00	977.393,36	684.175,35	772.140,75	745.751,13	753.668,02	751.292,95	752.005,47	751.791,72	1.001.782,48	926.785,25	949.284,42	942.534,67	944.559,60
CUMULATIVE PROFIT	-375.000,00	-750.000,00	227.393,36	911.568,71	1.683.709,47	2.429.460,60	3.183.128,62	3.934.421,57	4.686.427,05	5.438.218,76	6.440.001,25	7.366.786,50	8.316.070,93	9.258.605,60	10.203.165,20
Present Value	-360.576,92	-346.708,58	868.899,14	584.835,96	634.643,42	589.377,95	572.725,75	548.962,40	528.349,07	507.883,55	650.738,80	578.867,34	570.115,63	544.290,29	524.480,42
Net Present Value	-2.860.576,92	-3.207.285,50	-2.338.386,37	-1.753.550,41	-1.118.906,99	-529.529,04	43.196,72	592.159,12	1.120.508,19	1.628.391,74	2.279.130,53	2.857.997,87	3.428.113,50	3.972.403,78	4.496.884,20

The performance indicators derived from the above financial forecast are given in Table 32:

Table 32: Evaluation of the financial forecast

Performance indicators	Results
NPV	4.496.884,20 €
ROI	179,88%
IRR	16,80%
PAYBACK PERIOD (years)	6,25 years

Using the above financial results a Sensitivity Analysis of the NPV and IRR indicators has been performed for different sale prices of the SHIPLYS platform and different achieved market share as presented in the following tables and charts:

Table 33: Sensitivity Analysis of NPV

Sensitivity Analysis NPV	Market Share				
Price	5%	8%	10%	12%	15%
10.000,00 €	-1.665.733,22 €	1.072.777,04 €	2.898.450,54 €	4.724.124,05 €	7.462.634,30 €
11.000,00 €	-1.266.124,80 €	1.712.150,50 €	3.697.667,37 €	5.683.184,24 €	8.661.459,54 €
12.000,00 €	-866.516,39 €	2.351.523,96 €	4.496.884,20 €	6.642.244,43 €	9.860.284,79 €
13.000,00 €	-466.907,97 €	2.990.897,43 €	5.296.101,03 €	7.601.304,63 €	11.059.110,03 €
14.000,00 €	-67.299,56 €	3.630.270,89 €	6.095.317,86 €	8.560.364,82 €	12.257.935,27 €
15.000,00 €	332.308,86 €	4.269.644,35 €	6.894.534,68 €	9.519.425,02 €	13.456.760,51 €

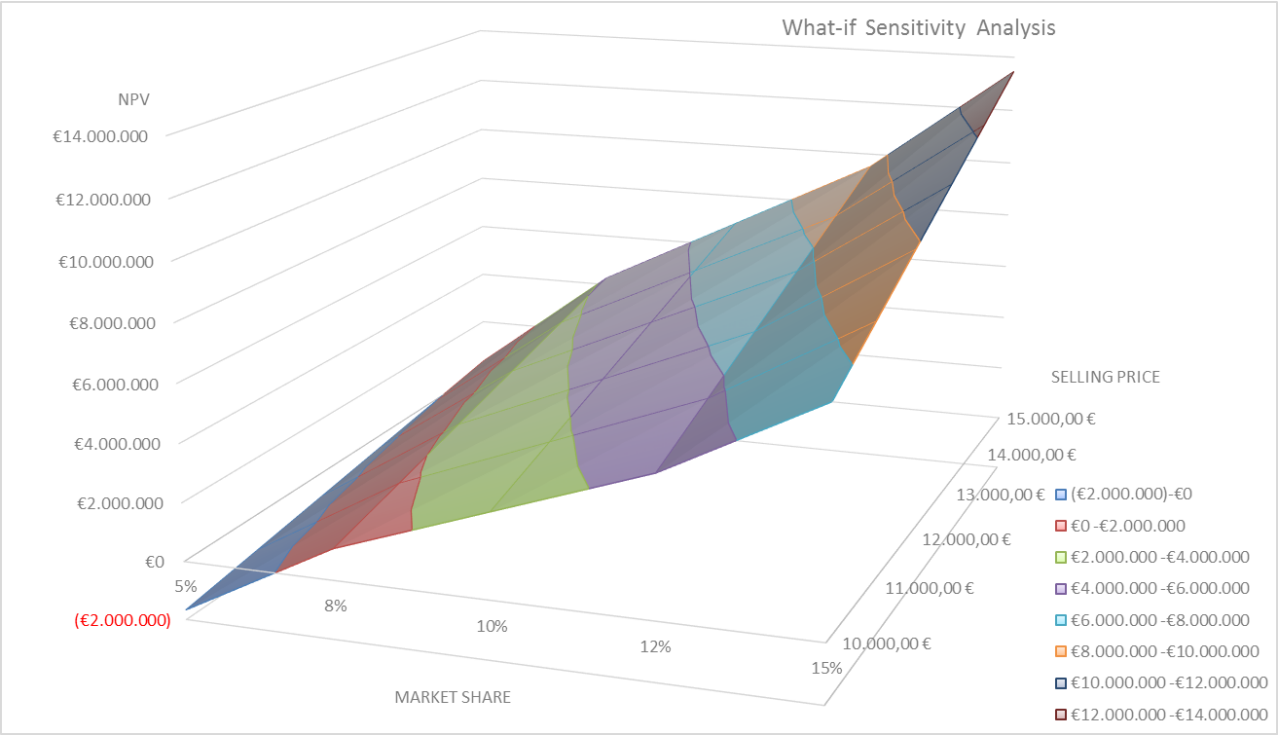


Figure 33: Sensitivity Analysis on NPV for different sale prices and market share

Table 34: Sensitivity Analysis of IRR

Sensitivity Analysis IRR	Market Share				
Price	5%	8%	10%	12%	15%
10.000,00 €	-3,18%	7,64%	12,87%	17,33%	23,09%
11.000,00 €	-1,21%	9,59%	14,90%	19,45%	25,37%
12.000,00 €	0,57%	11,40%	16,80%	21,46%	27,53%
13.000,00 €	2,22%	13,11%	18,61%	23,36%	29,58%
14.000,00 €	3,75%	14,73%	20,33%	25,18%	31,55%
15.000,00 €	5,19%	16,27%	21,97%	26,92%	33,44%

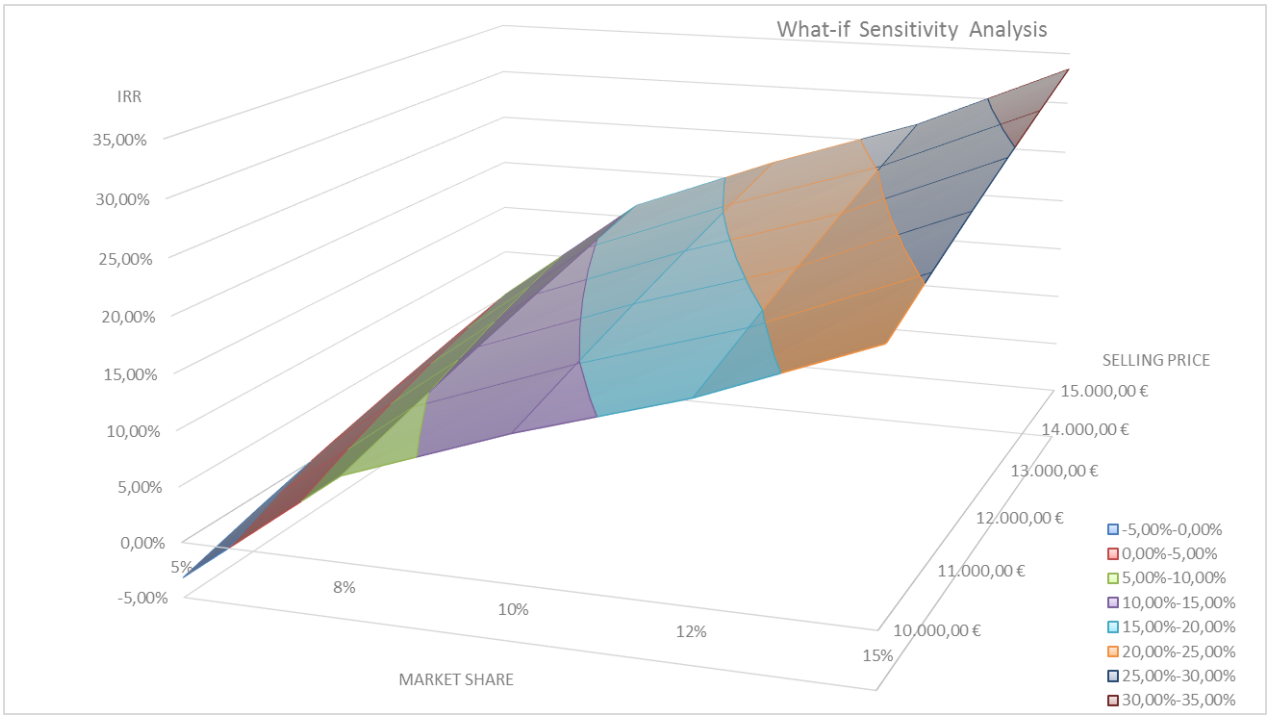


Figure 34: Sensitivity Analysis on IRR for different sale prices and market share

5.4.3.2 Scenario C assessment

Since the SHIPLYS project received 100% funding from the EU and no other funds have been invested so far by the partners of the project, a scenario for the further development, productification and exploitation of the SHIPLYS platform using estimations of the additional required funds until the complete introduction of the platform into the market, offers useful results.

In both examined cases (additional public source of funding or a bank loan) significant profit margins have been estimated while a sensitivity analysis for different parameters has been performed. The financial indicators present a very profitable scenario, since the initial investment cost used for the financial analysis is significantly lower than the total EU funding amount used in the previous scenarios.

6 Concluding remarks

The current deliverable analyses the steps towards the final exploitation of the SHIPLYS platform and the development of the business plan for a successful market entry of the SHIPLYS software tools.

Initially, an overview of the SHIPYS tool and its innovations have been presented. The advantages of the SHIPLYS platform have been presented regarding the market's trends as a result of the market monitoring during the implementation of the SHIPLYS project.

Next, the most important subjects towards the development of an efficient business plan have been discussed and presented, taking into consideration the opinions and intentions of the project's partners. The business exploitation of the SHIPLYS software tools is still under discussion among the partners taking part in the introduction of the SHIPLYS tool in the market.

As an additional tool for the final decisions for the business exploitation of the SHIPLYS platform, a detailed financial analysis has been performed, using different scenarios to estimate the future costs and revenues for the company that will undertake the task to exploit the platform and its tools.

More specifically, several performance indicators have been used to assess the economic performance, follow the progress against specified strategies and assist the business administrator(s) in executing adjustments to the business strategy when necessary. The performance indicators used in the analyses are Net Present Value (NPV), Internal Rate of Return (IRR) and Payback Period.

Additionally, a sensitivity analysis of these performance indicators has been performed for different scenarios of the pricing strategy to be decided and the succeeded market share, to determine the impact of different values used in the various estimations for the economic performance of the company.

The results of the financial analysis and the developments in the maritime industry reflect a positive future for the business exploitation of the SHIPLYS platform and its tools.

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Appendix

Questionnaire addressed to the market stakeholders

SHIPLYS - Ship Life Cycle Software Solutions

1. Introduction

SHIPLYS project (www.shiplys.com) aims to improve the competitiveness of shipyards and design offices by reducing time and costs involved in ship design and production. Within the project, we are developing SHIPLYS platform that integrates early ship design tools with life cycle, environmental and risk assessment tools. In order to set the business plan for commercial exploitation of the SHIPLYS platform, we would appreciate your assistance in obtaining the data related to the current usage of software tools and of related costs.

1. Company name (Optional)

2. Your position in the company *

3. Country *

4. Type of company *

- [ ] Shipyard
- [ ] Design office
- [ ] Other (please specify):

5. If shipyard, do you have a design office?

- [ ] Yes
- [ ] No
- [ ] If yes, indicate the average size of the design office?

6. Number of employees *

7. Shipbuilding processes within the company (multiple answers are possible) *

- [ ] Preliminary / Concept design
- [ ] Basic design
- [ ] Detail design
- [ ] Newbuilding
- [ ] Retrofitting
- [ ] Repair

2. Software tools that your company uses

8. Please specify software tools that your company uses in respect to different aspects of the design process. For each software tool, if possible, please indicate the type of licence and approximate price of the tool?

	Software tool	Cost (EUR)	Licence type (full or monthly based)	Number of licences
Tender requirements identification				
General ship configuration: Main dimensions and parameters estimation				
Hull form generation				
General arrangement				
Compartment definition				
Hydrostatic calculations				
Hydrodynamics and powering				
Loading conditions definition				
Determination of scantlings				
Weight and centre of gravity determination				
Stability analysis				
Sea keeping analysis				
Bill of materials				
Main equipment data sheets and requirements				
Production simulation				
Life cycle cost / environmental assessment				

9. In total, how much does your company spend on software tools (yearly)?

3. Interest for the SHIPLYS platform

10. How interesting do you find the platform that will integrate all the before mentioned ship design processes with life cycle cost, environmental and risk assessment? *

- [ ] Not at all interesting
- [ ] Slightly interesting
- [ ] Moderately interesting
- [ ] Very interesting
- [ ] Extremely interesting

11. If you have any comments, please make a note.