

APPLICATION OF THE MODULAR CONCEPT TO THE CREW OF A LANDING PLATFORM DOCK

APLICAÇÃO DO CONCEITO MODULAR À GUARNIÇÃO DE UM NAVIO POLIVALENTE LOGÍSTICO

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Abstract

A Landing Platform Dock is a ship that can be assigned to different scenarios that entail different tasks; therefore, the number of personnel on board can be considerable, increasing logistic and coordination efforts.

In order to find a solution to reduce manning without interfering with the mission's accomplishment, the application of the modular concept to the crew was analysed, bearing in mind the ship's concept of employment and operational requirements. Similar ships from foreign navies were analysed in order to obtain references about crew organisation and modules to embark according to the missions.

The methodology was based on a qualitative strategy with an inductive method, the structure consisted in a case study, and the research was based on a literature review and on interviews with specialists on the matter.

By applying the modular concept it is possible to reconfigure the crew for each mission, reducing human resources and, consequently, the associated complexity.

Keywords: Landing Platform Dock, Crew, Modular Concept, Force Projection.

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Resumo

O Navio Polivalente Logístico é um meio que pode integrar diversas capacidades e ser empregue em cenários com diferentes exigências, o que poderá originar a necessidade de uma guarnição com dimensões consideráveis e consequentemente maiores esforços de carácter logístico e de adaptação e coordenação das atividades a bordo.

No sentido de encontrar um compromisso entre a redução da guarnição deste navio, não descurando, no entanto, o cumprimento das missões, foi analisada a aplicação do conceito modular à sua guarnição, considerando para isso a tipologia de missões que poderão ser atribuídas, o seu conceito de emprego e requisitos operacionais. Como termo de comparação foi analisada a guarnição de navios similares de outras marinhas, permitindo a identificação da sua guarnição base, para uma navegação em segurança, e os diferentes módulos, sua constituição e organização, que poderão embarcar consoante a missão.

A metodologia seguida foi assente numa estratégia qualitativa com recurso ao método indutivo. O desenho da pesquisa foi o estudo de caso e as técnicas de recolha de dados por análise documental e entrevistas não estruturadas com especialistas na matéria.

Com a aplicação do conceito modular, adapta-se a necessidade de pessoal em cada tipo de missão, reduzindo os recursos humanos e consequentemente a complexidade associada.

Palavras-chave: Navio Polivalente Logístico, Guarnição, Conceito Modular, Projeção de Força.

Introduction

“[...] everything would be more effective and safer if Portugal already had [...] the landing platform dock envisaged in the military upgrade plans. The advantages would be tremendous”.
in Rodrigues e Santos (2007, p. 186).

Based on the policy guidelines provided in the National Defence Strategic Concept¹ (CEDN 2013) and in the Military Strategic Concept 2014 (CEM 2014), the Navy has included the acquisition of Force Projection Capabilities (EMA, 2015) in its ambitions for the future. These capabilities will allow Portugal and the Navy in particular to provide the mobility, sustainment, and logistic support required for the conduct of Landing Force (LF) operations in any part of the national territory or abroad, when cooperating with other states, guaranteeing the ability to project at sea or landward from the sea, autonomously and for a limited time-frame.

¹ Approved by Resolution of the Council of Ministers No. 19/2013 of 5 April.

Bearing in mind the specific guidelines and deployment scenarios within the scope of the Naval Component Capabilities, the National Defence doctrine sees the LPD² (Landing Platform Dock) as one of the assets deemed essential for the acquisition of Force Projection Capabilities.

In 2015, negotiations were held with the French Minister of Defence for the eventual acquisition of the ship *Siroco* but have since been discontinued. However, the then Minister of National Defence, through a n/n dispatch of 31 July 2015, determined that “coordinated efforts should continue being made to identify opportunities that will contribute to put Portugal in a position to consider the short term acquisition of a landing platform dock [...]”.

A Landing Platform Dock, commonly known as LPD, is an asset that can integrate a number of capabilities and that can be used in scenarios with different requirements. Thus, the size of the crew required on board can be considerable. Since it is imperative to reduce the human resource costs of the Armed Forces (Conselho de Ministros, 2013b), a compromise must be found between optimising their engagement and the missions they have been assigned, without, however, neglecting the latter.

Although a solution has not yet been found to facilitate the acquisition of an asset of this type, efforts must be initiated to ascertain the most suitable crew structure, taking into account potential repercussions for the current Armed Forces personnel, especially in the Navy. These efforts will allow the prior identification of gaps and difficulties that must be resolved so that a pre-structured, ready-to-implement solution is available when the ship is to be commissioned.

Thus, it is necessary to ascertain how to best configure the crew of this ship, integrating all the capabilities in a modular fashion and adapting them to the different scenarios in which they can be used.

Thus, this research paper aims to examine how the modular concept can be applied to the crew of an LPD without compromising the missions that have been assigned to it.

The object of study will be the characterisation of the base crew of an LPD, bearing in mind the minimum security requirements, the characterisation of the specialist groups in terms of capabilities, and the composition of the modules that will complement it. These modules can include only Navy elements, elements from the three branches of the Armed Forces, or from outside entities that possess different knowledge, expertise and equipment. As for the numbers of personnel to be embarked, a support tool will be developed to facilitate the planning of each mission.

The time-frame under analysis will be the current period of the Military Programming Law (LPM), which is in force for three quadrennial and is subject to review every four years. The current LPM approved on 18 May 2015 is due to be reviewed in 2018 and will become effective in 2019(Assembleia da República, 2015).

² LPD - North Atlantic Treaty Organisation (NATO) acronym that refers to a ship capable of transporting and projecting a LF in missions involving logistics actions to and from shore, by sea or by air.

The object of study resulted in the definition of the general objective (GO) of this paper, which is to analyse the application of the modular concept to the crew of an LPD, bearing in mind the following specific objectives (SO):

- SO1 – Characterising the type of missions that can be performed by an LPD, its concept of employment, and its operational requirements;
- SO 2 – Recognising how other navies operate their LPD;
- SO3 – Identifying the composition of the base crew of an LPD;
- SO4 – Characterising the modular concept and describing its organisation.

In order to achieve the objectives proposed, a research question and respective subsidiary questions were elaborated:

Research Question (RQ): How can the modular concept be applied to the crew of an LPD without compromising the missions?

Subsidiary Questions (SQ):

- SQ1 - What is the concept of employment of an LPD and what type of missions can it perform?
- SQ2 - How is an LPD crew organised in other navies?
- SQ3 - What entities, both within and outside the Navy, have capabilities that can be used in the assigned missions?

The methodology followed will be based on a qualitative strategy using the inductive method. A case study research design will be used, and the main data collection techniques employed will be a documentary review and unstructured interviews.

In addition to this introduction, the paper has been divided into four chapters. In the first chapter, a literature review will contextualise the issue, providing a deeper examination of the methodology and main concepts used; the second chapter will analyse the concept of employment and the operational requirements that have been deemed essential for this type of ship and identify the missions that it can perform. In the third chapter, a comparison study of Spanish and Dutch Navy vessels will be carried out in order to ascertain the most suitable characteristics for the ship that Portugal intends to acquire, and the fourth chapter will address the application of the modular concept to the base crew required for the safe operation of the ship, presenting the composition of the modules required for each type of mission. Finally, the conclusions will provide the answer to the RQ, which will result from the answers to the SQ, and make proposals for future research.

1. Contextualisation and methodology

This chapter is based on the guidelines set out in IESM (2015b) and aims to identify the main aspects of the research, which consist of a literature review, the research strategy, and the main concepts used in the analysis.

1.1. Literature review

Pursuant to the directives issued by the Ministry of Defence, the efforts to identify an LPD to acquire should be ongoing, and thus it was deemed necessary to revise the LPD Concept of Employment and Operational Requirements in force in the Navy so that they can be more easily adapted to the LPD available for acquisition. These concepts are currently under review and a working group has been set up for the purpose (Mourinha, 2016).

Given the strategic importance of this type of vessel, and although no options have yet been identified, several studies have been carried out, not only to highlight the importance of acquiring this asset but also to contribute to its acquisition and optimised operation. Some of the most relevant studies will be presented below.

Silva (2011) analyses the participation of the Armed Forces in humanitarian aid missions in the national territory and within the framework of the United Nations and the North Atlantic Treaty Organization (NATO) in order to identify the logistical and human capabilities of the Armed Forces, as well as the gaps in their performance in various humanitarian assistance scenarios. Among others, this study addressed the consequences of the storm in Madeira in 2010, where the Armed Forces played a key role in the salvage and rescue of several people. However, the author observed that during the course of that mission there was a “[...] gap in the Navy and, consequently, in the Armed Forces, due to the lack of a Landing Platform Dock [...] with command and control capabilities, organic assets for debarkation (landing craft), helicopters, and healthcare and medical services...” (Silva, 2011, p. 16).

Caldeira (2011) provides an analysis of the maritime force projection capability of the Portuguese Armed Forces, especially those of the Navy, under various scenarios and evolution of threats in order to identify potential weaknesses and the need for new assets. The LPD is again considered a critical asset to operationalise transport, Command and Control (C2), maritime force projection, and sustainment.

Situations in which bases cannot be set up to sustain the projected force, or where the conditions to project force are not met would be facilitated by an LPD equipped with flexible and redundant assets such as landing craft and helicopters. Moreover, it would allow the country to keep forces stationed outside the territorial sea of a foreign country, allowing for better response times.

Several studies have also been conducted on crew organisation, more specifically on how it will be reconfigured for each mission, especially in foreign navies such as the American, Canadian and Australian navies.

Work (2004), analyses the main objectives of the US Navy for the generation of 21st century surface ships: “get connected; get modular; get off-board; get unmanned”, which these Littoral Combat Ships (LCS) epitomise.

LCS are specifically devised for modular missions and must be capable of sustaining at least 20 different modular stations³ designed to facilitate rapid embarkation/debarkation. However, it must be taken into account that reconfiguring a ship for a specific mission includes the time required to train the crew for the new mission. Training the crew may take considerably longer than reconfiguring the ship.

One solution to drastically reduce the time spent in training may be to divide the crew into two modules, one to safely navigate the vessel and operate the self-defence systems, and another specifically trained for each type of mission.

MacKenzie and Tuteja (2006) analyse the most suitable structure to be applied to the new vessels that could replace the Canadian *Iroquois* and *Halifax*-class ships, which are nearing the end of their operational life cycle. The new vessels would be designed to adapt to all types of missions by applying the modularity concept, which would result in multirole plug and play configurations, reducing the number of systems, and thus the personnel responsible for those systems.

Along the same lines, the Australian Navy (Glanville, 2010) is pondering the acquisition of a new class of multirole ships to use on the missions carried out by four other classes, namely maritime patrolling, mine countermeasures, hydrographic surveying, and environmental monitoring.

The optimisation of resources, specifically human resources, is a visible and constant concern for several navies, regardless of the size and function of the vessels under consideration. Thus, this study will be based on the same concern but will focus on its applicability to an LPD. The base crew and the modules to be embarked on each type of mission will be identified, specifically in terms of staff numbers, to assess the feasibility of applying the modular concept.

1.2. Research strategy

As mentioned above, this study will follow a methodology based on a qualitative strategy using the inductive method and a case study research design.

The qualitative strategy allows for deeper understanding of the object under study, while foregoing data measurements and statistical analysis. The study essentially relies on interviews with experts on the matter at hand, on the observation of the object under study, or others like it, in terms of behaviour, method of operation, or organisation, and on a documentary review, aiming to understand the importance of the object under study, its contributions, and the developments required to achieve the proposed objective.

The inductive method begins with the observation of specific facts pertaining to the object under study, examining their nature, composition, behaviour and, when appropriate,

³ “[...] three for onboard weapon systems; seven for manned or unmanned off-board systems or sensors; and ten for off-board system maintenance and support. [...] remaining LCS design teams are free to incorporate additional mission module stations [...]”.

differences and similarities with other objects that contribute to similar objectives. Relevant data and characteristics will be drawn from this analysis, and a general theory will be developed that can be applied to the object under study or to any similar one.

The case study will serve to collect detailed information about a single object of study, describing it in a rigorous way in order to understand it (IESM, 2016).

Thus, the aim is to carefully examine the organisation of an LPD crew, using similar cases such as the LPD operated by the Spanish and Dutch navies, in order to construct a theory that can be adapted to the capability that the Portuguese Navy intends to acquire.

In the exploratory phase, the main documents justifying the need to acquire this ship, its concept of employment, the missions it will perform, and the operational requirements were analysed in order to identify the capabilities required to carry out the assigned tasks. The interviews conducted with several experts in different areas were an essential addition and mainly aimed to identify the modules to be considered, their composition and staff numbers, which were later linked to the tasks that the vessel may be required to perform.

This examination focused on the *Galicia* and *Castilla* LPD of the Spanish Navy, and on the *Rotterdam* and *Johan de Witt* LPD of the Dutch Navy, with the aim of analysing how their crew is organised, both in cruising navigation and in navigation with specific missions, in order to understand how this type of ship is operated and find a general solution that can be adapted to all future assets.

1.3. Conceptual framework

The definitions of Crew, Capability, and Module have been deemed essential for this research, as the concepts will be used throughout the study.

A crew is a group of expert persons whose main function is to ensure the suitable level of operation and maintenance of a ship and of the equipment considered vital to safe navigation, which can be supplemented by a larger number of elements, depending on mission range, size of ship, and equipment configuration and automation (EMA, 1999).

The term Capability, especially in the military, is understood as a set of articulated and complementary elements that contribute to the performance of a given task, and which include aspects related to doctrine, organisation, training, material, leadership, personnel, infrastructures, and interoperability (DOTMLP II).

A Module is a part of a system that is responsible for a well-defined task and that will contribute, alone or in combination with other modules, to the acquisition of a given capability.

A module can be an integral part of a modular construction ship, which means that a significant portion of the ship was built in modules that were later combined to make up the final structure. Some of the ships used by the Portuguese Navy have a modular structure, namely the *Vasco da Gama* class. This design makes it easier to detach each module for maintenance, repair, or upgrading purposes outside the ship (Fonseca, 2016). On the other hand, it can also contribute to its modular capability, which is based on speed and flexibility

when installing onboard capabilities such as weapons, missiles, unmanned vehicles, special operations forces and their material and personnel, etc. (MacKenzie and Tuteja, 2006). A module can include material and/or personnel.

Therefore, the aim of this study is to configure a crew capable of performing a set of tasks by defining modules with the personnel characteristics and numbers required to complement it, thus applying the modular concept.

2. Characterisation of the operation of an LPD

The acquisition of an LPD should take into account the concept of employment of this type of ship.

This asset is characterised by its versatility and should allow and facilitate the transport, debarkation, and logistic support of marine forces such as the Battalion Landing Team (BLT), or other military and civilian forces and assets, national or from other countries, as well as evacuate civilians, and must be capable of operating in the absence of port facilities.

In addition to the projection of amphibian assets, the ship must also have the C2 capability of a Naval Force and provide Role 2⁴ medical support according to the LPD concept of employment in force in the Navy.

The LPD and the BLT complement each other and their combination represents the much-desired power projection capability. The BLT is a modular marine force geared towards specific tasks.

This chapter aims to achieve SO1 and answer SQ1.

2.1. Concept of employment and type of mission

The document that defines the Missions of the Armed Forces (MIFA 2014)⁵ is based on the specific guidelines defined in CEM 2014, which in turn provides guidelines for the constitution of a military instrument capable of meeting the national needs, interests, and responsibilities provided for in the CEDN 2013, in accordance to the missions assigned to the Armed Forces (Assembleia da República, 2014).

The set of military capabilities required to comply with MIFA 2014 includes, among others, three sets of forces composed of elements from the three branches of the Armed Forces:

- Immediate Reaction Force (IRF): A high readiness response force capable of intervening in a wide range of operations, characterised by its high degree of readiness, flexibility, and projection and sustainment capabilities (approximately 30 days), both in the national territory and abroad, whenever the safety of Portuguese

⁴ The vessel must be prepared to receive evacuations from other assets with resuscitation, treatment, and stabilisation capabilities, as well as urgent dental care capabilities, as stated in AJP-4.10 (NATO, 2015). Depending on the mission, the ship may have emergency surgery and post-operative care capabilities.

⁵ Approved by the Supreme Council for National Defence (CSDN) on 30 July 2014.

citizens is at stake. It can perform evacuation of non-combatants in permissive or non-permissive environments and in complex emergencies such as natural disasters and humanitarian aid scenarios;

- Sovereignty Action Permanent Forces (FPAS): A permanent force geared towards air defence missions, patrolling, surveillance and inspection, search and rescue, public interest, and disaster response in the national territory and in the jurisdiction areas of national responsibility;
- Modular Forces Set (CMF): Joint modular forces at high readiness for deployment across the full spectrum of missions in support of Alliances and Partnerships, formerly known as National Detached Forces (FND).

Because an LPD has organic landing and force projection capabilities, it can be deployed in various missions performed by the three types of forces mentioned above.

Thus, the vessel's concept of employment, in accordance with current doctrine, is to provide the Navy with the ability to project and sustain forces ashore and to provide health and logistic support to forces or units at sea and on land, support to diving operations, emergency humanitarian assistance, and other activities of national interest (Mourinha, 2016).

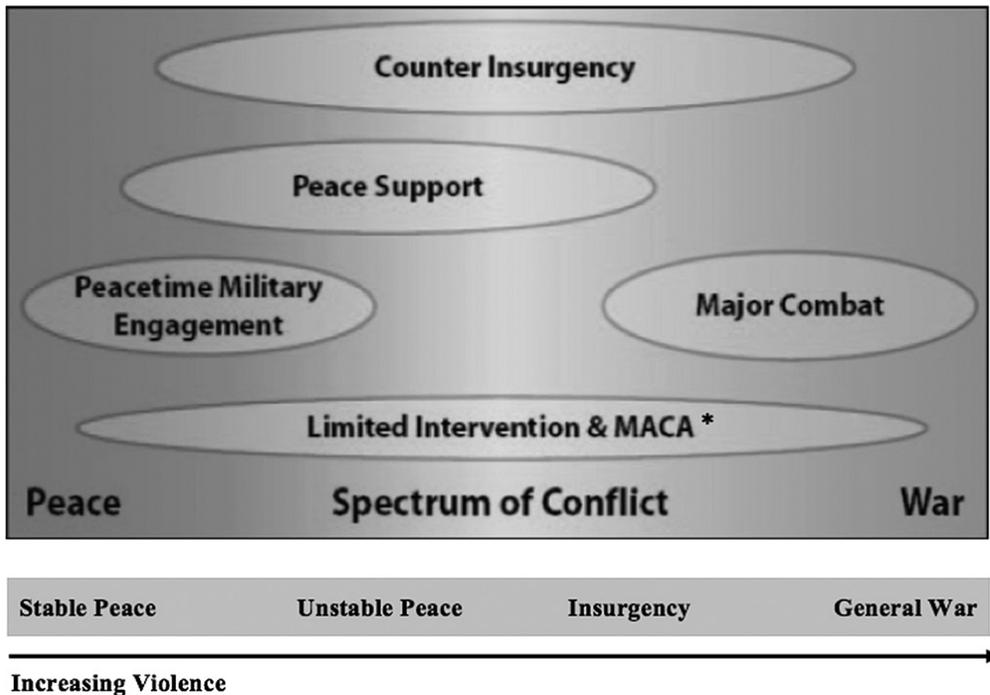
The current structure of the Marine Corps assets and capabilities is based on these groups of forces, the three mentioned above and a second CMF on standby (CMF STBY). Thus, the BLT will be created from the breakdown of the CMF and CMF STBY and will be subsequently reconfigured as a battalion (Gonçalves, 2016).

Based on the missions identified, this type of vessel should generally have the following capabilities:

- Force Projection;
- C2 operations;
- Logistic support;
- Non-Combatant Evacuation Operations (NEO);
- Complex emergencies operations.

The range of missions that can be assigned to an LPD can cover the full spectrum of conflict, as depicted in Figure 1, which confirms the large multirole capability of these ships.

Based on the missions that can be performed by an LPD and on its concept of employment, and in accordance with current doctrine (Mourinha, 2016), a number of tasks have been outlined.



*MACA = Military Aid to the Civil Authorities

Figure 1 – Spectrum of conflict

Source: (adapted from Ministry of Defence, 2013)

2.2. Operational requirements

According to NATO publication AAP6, an Operational Requirement (OR) can be defined as the need to acquire, in a timely manner, a resource required to build a capability that will enable the achievement of the objectives of an operation, mission, or action, both civil and military.

At a time when Portugal is in the process of identifying an LPD for possible acquisition, it is important to define the OR that this vessel must comply with, so that it includes the capabilities necessary to carry out the tasks referred to in the previous subchapter.

The OR can be divided into two types: those that relate to the structure of the ship and those that relate to the need to carry out specific tasks. These tasks can also be assigned a priority and subdivided into three categories: Mandatory (M) - that must always be complied with, even if the ship is modified; Highly Desirable (HD) - if complied with, they greatly contribute to increase the military and operational value of the ship; and Desirable (D) - recommended from an operational perspective.

Based on the current doctrine and on the proposal to amend it, the OR that include the need to perform specific tasks were grouped by capability, and, in line with the objective of

this study, these OR will later form the set of modules to embark, depending on the task that must be performed.

3. LPD in other navies

This chapter aims to examine the LPD operated by foreign navies in order to determine their method of operation and organisation, thus achieving SO2 and attempting to answer SQ2.

The Spanish and Dutch navies LPD were analysed, specifically with regard to crew organisation.

3.1. The Spanish Navy

The Spanish Navy operates two LPD, the *Galicia* and the *Castilla*, which entered into service in 1998 and 2000, respectively.

According to *Alférez-de-Navío* [ensign] Jose Gonzalez(Gonzalez, 2016), an officer on the *Galicia*, these ships are essentially used to transport forces and vehicles, and therefore operate amphibious vessels and helicopters. They are capable of embarking four Landing Craft Mechanized (LCM)⁶ from a unit ashore with a four-member crew and helicopters, such as the *Augusta Bell 212*, the *Sea Hawk 60B*, the *Sea Hawk- 3D*, and the *Huge-500*. The hangar supports up to four large helicopters⁷ (*Sea Hawk 60B* and *Sea Hawk-3D*) and six small ones⁸ (*Augusta Bell 212* and *Huge-500*).

Although primarily employed in amphibious operations, these ships have also been used for peacekeeping operations, such as fighting piracy off the coast of Somalia, and for humanitarian relief operations. They can also act as a C2 ship for Amphibious Forces, Landing Forces or Naval Forces.

The base crew (the *Galicia's* in this case) is composed of 189 elements – 17 officers, 31 sergeants and 141 ratings – and the ship has the capacity to embark an additional 614 non-crew elements. Table1 indicates the ship's accommodation capacity.

As in the Portuguese Navy frigates, the crew is organised into four departments: 46 elements for operations, 56 for propulsion and energy, 49 for weapons and electronics, and 36 for logistics, in addition to the commander and executive officer.

⁶ A 25-meter long landing craft capable of carrying one combat vehicle or 125 men.

⁷ Over nine tons load capacity.

⁸ Up to six tons load capacity.

Table 1 – Accommodation capacity of the Galicia

Module	Category	Number
Crew	Officers	22
	Sergeants	40
	Ratings	171
	Total	233
General Staff	Officers	18
	Sergeants	12
	Ratings	-
	Total	42
Helicopter crew/maintenance	Officers	10
	Sergeants	12
	Ratings	12
	Total	30
Landing force	Officers	25
	Sergeants	30
	Ratings	447
	Total	502
Sick bay	Total	4
Total accommodation capacity	Officers	75
	Sergeants	94
	Ratings	630
	Sick bay	4
	Total	803

Source: (Author, 2016).

The next two sub-chapters will provide a description of two different missions where these ships were committed, Operation Atalanta 2015 and Operation Haiti 2010, and where the crew was reconfigured to respond to the mission requirements.

3.1.1. The Galicia LPD in Operation Atalanta in 2015

Between April and October 2015, the *Galicia* took part in Operation Atalanta for the third time, fighting piracy off the coast of Somalia and operating for the first time as command ship of the force.

It set sail from Rota Naval base carrying a total 265 troops (223 men and 42 women), divided into 195 crew elements (including reinforcements from other units), 19 General Staff

members, 39 members of the helicopter team, 11 members of the marines boarding team, one dental practitioner providing Role 1 care, and one other rank in charge of Special Actions Detachment (SAD) vessels that would embark at a later date. The reinforcements usually come from the Marine Corps and guarantee and reinforce support services such as laundry, kitchen, and bakery.

Upon arrival at the operations area and after taking over as command ship for the operation, ten more General Staff members boarded the ship, as well as eight physicians for the Role 2 capability, and the 19 members of the SAD. Tables 2 and 3 provide a summary of the crew and modules embarked before and after arrival in the operations area.

Table 2 – The Galicia crew and modules that set sail from Rota naval base for Operation Atalanta 2015

	Officers	Sergeants	Ratings	Civilians	Total
Crew	22	27	146	0	189
Support services	0	0	6	0	6
Role 2	0	0	0	0	0
SAD	0	0	1	0	1
Boarding team	0	1	10	0	11
General Staff	11	8	0	0	19
Helicopters	8	13	17	1	39
Total	40	49	174	1	265

Source: (Author, 2016).

Table 3 – The Galicia crew and modules after taking over as command ship for Operation Atalanta 2015

	Officers	Sergeants	Ratings	Civilians	Total
Crew	22	27	146	0	189
Support services	0	0	6	0	6
Role 2	8	0	0	0	8
SAD	1	5	14	0	20
Boarding team	0	1	10	0	11
General Staff	18	11	0	0	29
Helicopters	8	13	17	1	39
Total	57	57	187	1	302

Source: (Author, 2016).

3.1.2. The Castilla LPD in the Humanitarian Aid mission in Haiti in 2010

In January 2010, a 7.3-magnitude earthquake on the Richter scale shook Haiti, leaving more than 200,000 dead, thousands missing, and hundreds of thousands displaced. Faced with the scale of the tragedy, the Spanish government, in coordination with the Haitian government, sent a military contingent to participate in the operations to provide humanitarian aid and assistance to the victims of the disaster.

The LPD projection capability made the ship particularly suited to transport that contingent, as it is capable of operating independently to a large degree and remain in the area for long periods of time. The contingent was composed of 450 troops, had health care facilities both onboard and landside, and its capabilities included producing and distributing drinking water, cleaning up debris, opening roads, and moving loads, as well as self-defence capabilities.

On 22 January 2010 the *Castilla* set sail from Rota naval base fitted for the mission, carrying a health care unit, a four-helicopter air unit, a unit with two landing craft, a marines tactical subgroup (comprising a diving unit, a resupply unit, and a security unit) and an underwater reconnaissance and demolition unit, as well as a General Staff in charge of intelligence, operations, air operations, legal advice, and public information (Ministerio de Defensa, 2010).

According to *Janes* (IHS, n.d.), the ship's base crew is composed of 190 troops, including a five-person medical team (Role 1) providing primary medical care to the contingent. Table 4 presents a brief list of the embarked elements.

Haiti is an archipelagic state, inviting a comparison to the 2010 mission in the Madeira archipelago, which could have been facilitated by an LPD.

Table 4 – Crew and modules of the Castilla in the Humanitarian Aid Operation in Haiti

Module	Numbers
Crew	190
Healthcare Unit	56
Air Unit	39
Marines tactical subgroup	150
Reconnaissance and underwater demolition unit	7
General Staff	7
Total	449

Source: (Author, 2016).

3.2. The Dutch Navy

Like the Spanish Navy, the Dutch Navy also operates two LPD, the *Rotterdam* and the *Johan de Witt*, commissioned in 1998 and 2007, respectively. The *Rotterdam* took part in the same project as the Spanish ships.

According to Commander Peter van der Klugt (Klugt, 2016), the person responsible for the LPD weapons system in the Dutch Ministry of Defence, these ships are used in a similar capacity as the Spanish vessels, with a slightly smaller crew. The *Rotterdam* crew is composed of 128 troops (16 officers, 28 sergeants and 84 ratings) and the *Johan de Witt* has 151 troops (17 officers, 32 sergeants and 102 ratings); however, information on the vessels' organisation by departments and services was not made available.

These ships can embark several types of landing craft, as shown in Table 5, namely four Landing Craft Vehicle Personnel MK2/3 (LCVP) or four LCVP MK5, two Landing Craft Utility MK9 (LCU) or two LCM-8, with the respective crews. The *Rotterdam* is similar to the Spanish ships in terms of helicopter capacity, and the *Johan de Witt* can support two large helicopters simultaneously, currently the EH101 and the NH 90.

Including its base crew, the *Rotterdam* can accommodate 739 elements and the *Johan de Witt* can carry 701 elements, and the logistic support onboard ensures that there are no restrictions during embarkation, as it includes a support crew (cooks, bakers, etc.) that removes the need for embarking additional elements.

Table 5 – Landing craft

Landing craft	Country	Crew (ratings)	Length (m)	Capacity
LCVP MK2	Netherlands	3	16	28 men
LCVP MK3	Netherlands	3	16.9	34 men or seven ton equipment or two light vehicles.
LCVP MK5	United Kingdom	3	15.5	35 men with two ton equipment or eight ton vehicles and other equipment.
LCU MK9	United Kingdom	5	35.8	153 men or 65 ton vehicles.
LCM-8	USA	4	22.5	110 men or a combat vehicle or 67.5 ton equipment.

Source: (Author, 2016).

4. Application of the modular concept

This chapter aims to present the basic organisation of an LPD base crew and the modules required (and their composition) to perform each mission, contributing to achieve SO3 and SO4 and answering SQ3.

The process will take into account the information obtained from the Spanish and Dutch Navy vessels analysed in the previous chapter, while making the necessary adaptations to the Portuguese Navy.

4.1. The base crew of an LPD

The base crew of a ship must be capable of permanently ensuring the basic conditions for safe navigation and of responding effectively to internal emergency situations related to damage limitation and first echelon maintenance⁹ that arise from operating and steering the platform. Thus, each ship has unique crew organisation requirements, depending on size, type of equipment, and level of automation.

Because an LPD has not yet been identified for acquisition, assessing the basic requirements in terms of personnel is not an easy task. Even after selecting a vessel, the doctrine and organisation of the country of origin may not be the same as the Portuguese, and adjustments will have to be made regarding personnel requirements. The above occurred when Portugal attempted to acquire the *Siroco* LPD, which required about 224 elements according to the French Navy doctrinal and organisation documents.

A base crew of about 108 elements (16 officers, 18 sergeants, 64 ratings) was defined to integrate the *Siroco* in the Portuguese Navy, as shown in the chart in Figure2, and those figures will be used for the purposes of this study. However, this organisation was based on the minimum requirements for safe navigation between France and Portugal, and did not include the operation of most of the onboard equipment and mechanisms (Afonso, 2016).

The base crew defined was based on the administrative organisation normally used in frigates, which can accommodate four departments and their respective services.

⁹ Operator level maintenance.

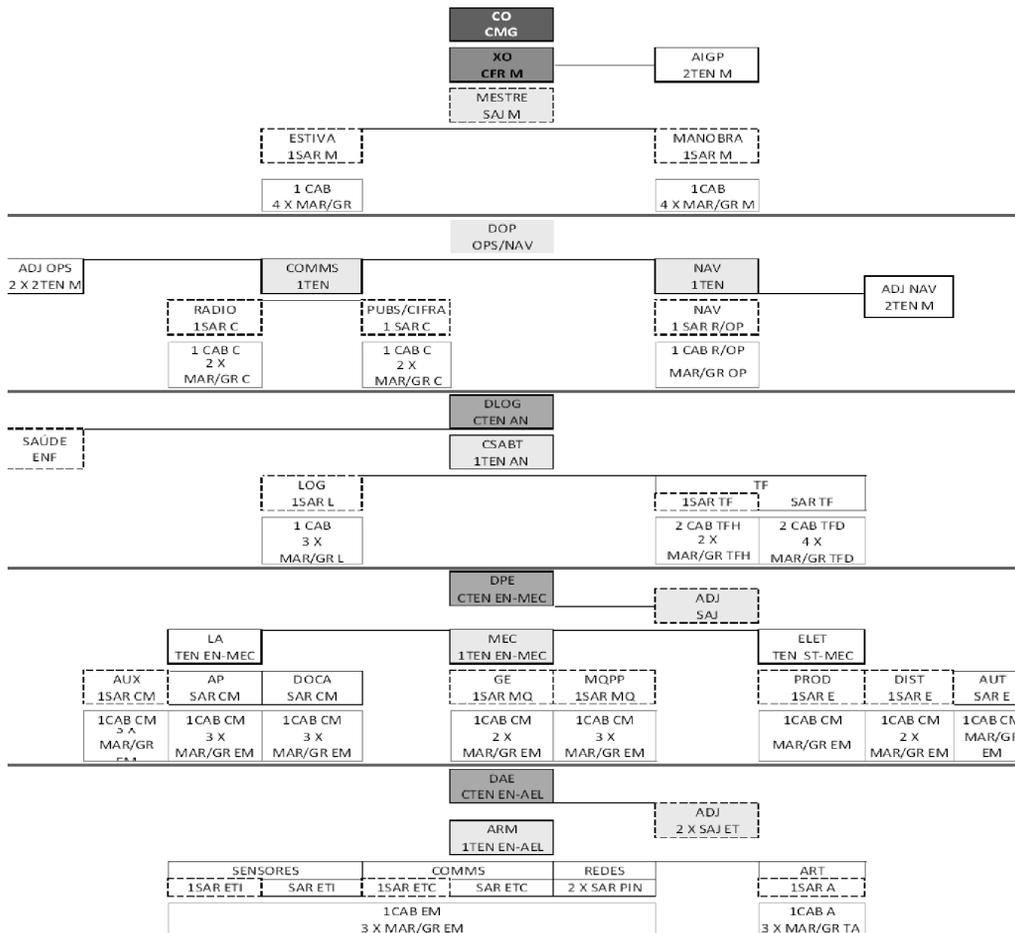


Figure 2- Base chart of an LPD crew for the purposes of this study

Source: (Afonso, 2016).

4.2. Identification and composition of the modules

Based on the OR provided in the current doctrine and on the proposal to amend them, the capabilities required for an LPD were identified and combined, and the different modules were elaborated. A total 13 modules were created, some of which may be divided into two or more submodules, depending on what type of capability they provide.

The following modules and submodules were identified:

- Module 1 - General Staff
- Module 2 - Helicopters

- Submodule 2.1 - *EH 101*¹⁰
 - Submodule 2.2 - *Lynx MK95*
- Module 3 - Marines
 - Submodule 3.1 - FPAS
 - Submodule 3.2 - IRF
 - Submodule 3.3 - CMF
 - Submodule 3.4 - BLT
 - Submodule 3.5 - Unmanned Aerial Vehicle (UAV)
- Module 4 - Diving
 - Submodule 4.1 – Autonomous Underwater Vehicle (AUV) and Countermine Warfare Detachment (DGM)
 - Submodule 4.2 - Hyperbaric chamber
 - Submodule 4.3 – General diving
- Module 5 - Foreigners and Border Service (SEF)¹¹
- Module 6 – National Authority for Civil Protection (ANPC)¹²
- Module 7 - Army¹³
- Module 8 - Healthcare
 - Submodule 8.1 – First Echelon
 - Submodule 8.2 – First Expanded Echelon
 - Submodule 8.3 – Second Echelon
- Module 9 - Landing Craft
- Module 10 – Submarine Rescue Vehicle (SRV)
- Module 11 – Transportable Radar and Communications Jamming and Simulations Vans (TRACSVAN)
- Module 12 - Operations
- Module 13 – Support services

¹⁰ The flight crew for each helicopter is composed of four elements (Pilot-in-command, Co-pilot, systems operator, and rescue swimmer), and the “land” team, which includes five sergeants and eight ratings, comprises two maintenance teams that provide H24 maintenance (Azevedo D. J., 2016).

¹¹ Based on prior missions, this module consists of two inspectors responsible for identifying the persons to be evacuated/transported, handling and organising all individual cases, and later handing them over to the competent authorities (Chumbo, 2016).

¹² This module can be divided into submodules according to the type of mission performed, and can include a total 265 elements (Martins, 2016).

¹³ According to current doctrine, and due to accommodation limitations, this module can only include 654 troops (64 officers, 95 sergeants and 495 ratings).

These modules can be embarked individually or in different combinations, always taking into consideration the space available for accommodations and for the material and equipment required. For example, only one of the two “Module 2” submodules can be embarked, depending on the maximum number of embarked helicopters, or a combination of both.

“Module 6” is primarily used for humanitarian relief missions and can replace or complement “Sub-module 3.2”. They can be embarked together or separately, depending on the ship’s requirements and capacity.

“Module 9” may be included in the base crew or be external to the ship, as in the Spanish and Dutch navies.

“Module 13” will only be included if the total of shipped elements allows it. For the purposes of this study, this module will include more than 300 embarked elements, as in the *Galicia* configuration for the *Atalanta* mission in 2015.

The staff numbers by category for each module have been identified in order to project their accommodation requirements.

4.3. Mission-specific personnel needs

The current doctrine has outlined scenarios for military intervention by the Portuguese Armed Forces. Sub-scenarios were created for each of these scenarios, and these resulted in the missions outlined in MIFA 2014, which can be further divided into different tasks for each asset deployed.

Thus, when planning an operation, the type of scenario, the type of mission, the tasks to be performed, and the capabilities required to perform those tasks must be taken into account, as they will lead to the definition of staff and material requirements. The decision-making process depicted in Figure 3 illustrates this planning process, whereby capabilities are provided by different modules/sub-modules.

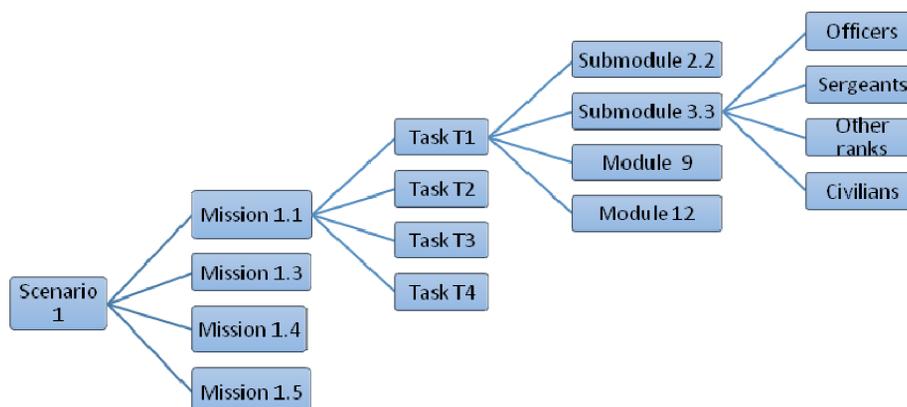


Figure 3 – Diagram illustrating the chain of decisions in the planning of an operation

Source: (Author, 2016).

Considering that several tasks can be carried out in the same mission, and that different missions can share the same tasks, it is important to define which modules/submodules are required for each task. Thus, for the purposes of this study, a relation was established between the modules/submodules and the tasks that can be performed by an LPD.

The personnel numbers for the modules/submodules required to perform one or more tasks can have a relevant impact on the planning of an operation, and are constrained, among others, by the ship's accommodation and food storage capacity, and may require embarking additional logistic support elements, or reducing the staff of each module/submodule.

Furthermore, integrating the modules/submodules on board the ship may also be necessary to guarantee full interoperability with the crew. While some modules, such as the ANPC or the Army, may be considered autonomous and do not participate in onboard activities, others, such as operations or landing craft personnel, may require prior integration. Therefore, the modules/submodules and their personnel requirements must be defined as far in advance as possible.

Based on this assumption, a spread sheet was elaborated using Excel dynamic tables, as shown in Figure4, allowing the person in charge of planning to select the tasks the LPD will perform, from which the modules and submodules that contribute to each task will emerge. The embarked personnel will be selected and their numbers changed, if required, to comply with the ship's loading capacity (808 elements for the purposes of this study and in accordance with current doctrine). Finally, the staff numbers by category and the final total will be obtained; the latter already includes the base crew.

Figure5 illustrates the process of elaborating the spread sheet, based on a humanitarian aid scenario that includes a Marines force and a Divers Detachment, an Army brigade echelon command, and Air Force transport helicopters. In addition to Armed Forces assets, civilian entities such as the ANPC should also be considered, as they may complement the capability to provide support in complex emergencies.

Using the above example, the support tool will allow the planner to define the personnel numbers that can embark in the LPD without exceeding its capacity, choosing, for example, between the Army brigade and the Marines force. The marines were chosen and a final total 649 elements were selected to embark (Figure 4).

Task modules and submodules

Rótulos de Linha	Sum of OFFICERS	Sum of SERGEANTS	Sum of RATINGS	Sum of CIVILIANS
T07 - Acting as a joint-headquartered vessel in national operations				
M01 - General Staff	6	14	1	
M08.1 - Medical First Echelon	2	2	1	
M12 - Operations	1	7	23	
T13 - Execute and conduct medical evacuation and humanitarian support operations.				
M02.1 - EH 101	8	13	8	
M02.2 - Lynx MK95	8	16	15	
M03.2 - IRF	5	19	93	
M05 - SEF	2	0	0	
M06 - ANPC				265
M08.3 - Medical Second Echelon	20	8	14	
M09 - Landing Craft	0	0	16	
M12 - Operations	1	7	23	
M13 - Support services	0	0	6	
T14 - Act as platform for the operation of transport helicopters.				
M02.1 - EH 101	8	13	8	
M02.2 - Lynx MK95	8	16	15	
M08.1 - Medical First Echelon	2	2	1	
M12 - Operations	1	7	23	
T20 - Transport, disembark and logistically support national or foreign military units and forces, as determined above, in particular when engaged in peace and humanitarian operations under the auspices of the UN or OSCE.				
M02.1 - EH 101	8	13	8	
M02.2 - Lynx MK95	8	16	15	
M03.2 - IRF	5	19	93	
M03.3 - CMF	11	30	172	
M05 - SEF	2	0	0	
M06 - ANPC				265
M08.3 - Medical Second Echelon	20	8	14	
M09 - Landing Craft	0	0	16	
M12 - Operations	1	7	23	
M13 - Support services	0	0	6	

Selected Tasks

Modules to be selected

Staff numbers by module selected

TASK	MODULE	Rótulos de Linha	Sum of OFFICERS	Sum of SERGEANTS	Sum of RATINGS	Sum of CIVILIANS
T01 - Participate in amphi...	M01 - General Staff	M01 - General Staff	6	14	1	
T02 - Ensure the forces lan...	M02.1 - EH 101	M02.1 - EH 101	8	13	8	
T03 - Ensure sanitary supp...	M02.2 - Lynx MK95	M03.2 - IRF	5	19	93	
T04 - Carry out the transp...	M03.1 - FPAS	M04.1 - AUV/DGM	2	4	4	
T05 - Collaborate in the pr...	M03.2 - IRF	M04.2 - Hyperbaric chamber	1	2	1	
T06 - Collaborate in subm...	M03.3 - CMF	M06 - ANPC				265
T07 - Acting as a joint-hea...	M03.4 - BLT	M08.3 - Medical Second Echelon	20	8	14	
T08 - Participate in peace ...	M03.5 - UAV	M09 - Landing Craft	0	0	16	
T09 - Participate in nation...	M04.1 - AUV/DGM	M12 - Operations	1	7	23	
T10 - Carry out national re...	M04.2 - Hyperbaric chamber	M13 - Support services	0	0	6	
T11 - Perform naval prese...	M04.3 - General diving					
T12 - Execute and conduct ...	M05 - SEF					
T13 - Execute and conduct ...	M06 - ANPC					
T14 - Act as platform for t...	M07 - Army					
T15 - Collaborate in tasks ...	M08.1 - Medical First Echelon					
T16 - Conduct on-board a...	M08.2 - Medical First Expan...					
T17 - Carry out control of t...	M08.3 - Medical Second Ech...					
T18 - Constitute itself as a ...	M09 - Landing Craft					
T19 - Acting as the flagshi...	M10 - SRV					
T20 - Transport, disembar...	M11 - TRACSVAN					
T21 - Constitute itself as a ...	M12 - Operations					
	M13 - Support services					

Totals	
Officers	43
Sergeants	67
Ratings	166
Civilians	265
Total to embark*	649

≤ 808

*Numbers of base crew are considered

Figure 4 – Planning support worksheet

Source: (Author, 2016).

Selected Tasks

TASK
T01 - Participate in amphibious or joint...
T02 - Ensure the forces landed support...
T03 - Ensure sanitary support to the fo...
T04 - Carry out the transport and ensur...
T05 - Collaborate in the protection of...
T06 - Collaborate in submarine rescue...
T07 - Acting as a joint-headquartered...
T08 - Participate in peace support ope...
T09 - Participate in national or interna...
T10 - Carry out national representation...
T11 - Perform naval presence actions...
T12 - Execute and conduct maritime an...
T13 - Execute and conduct medical eva...
T14 - Act as platform for the operation...
T15 - Collaborate in tasks resulting fro...
T16 - Conduct on-board air assets con...
T17 - Carry out control of transport heli...
T18 - Constitute itself as a platform fo...
T19 - Acting as the flagship of a Natio...
T20 - Transport, disembark and logisti...
T21 - Constitute itself as a platform to...

The "Selected tasks" table defines the tasks to be assigned:

- T7: Acting as an embarked joint headquarters in national operations;
- T13: Carrying out and leading medical evacuation and humanitarian support operations;
- T14: Providing a platform for the operation of transport helicopters;
- T20: Transporting, disembarking and providing logistic support to national and foreign military units and forces (...).

Task modules and submodules

Task	Module	Submodule	Sum of OFFICERS	Sum of SERGEANTS	Sum of RATINGS	Sum of CIVILIANS
T01 - Participate in amphibious or joint...	M01 - General Staff		6	14	1	
T02 - Ensure the forces landed support...	M02.1 - EH 101		8	13	8	
T03 - Ensure sanitary support to the fo...	M02.2 - Lynx MK95		5	19	93	
T04 - Carry out the transport and ensur...	M03.2 - IRF		2	4	4	
T05 - Collaborate in the protection of...	M03.3 - CMF		1	2	1	
T06 - Collaborate in submarine rescue...	M03.4 - BLT					
T07 - Acting as a joint-headquartered...	M03.5 - UAV					
T08 - Participate in peace support ope...	M04.1 - AUV/DGM					
T09 - Participate in national or interna...	M04.2 - Hyperbaric chamber					
T10 - Carry out national representation...	M04.3 - General diving					
T11 - Perform naval presence actions...	M05 - SEF					
T12 - Execute and conduct maritime an...	M06 - ANPC					
T13 - Execute and conduct medical eva...	M07 - Army					
T14 - Act as platform for the operation...	M08.1 - Medical First Echelon...					
T15 - Collaborate in tasks resulting fro...	M08.2 - Medical First Expe...					
T16 - Conduct on-board air assets con...	M08.3 - Medical Second Ec...					
T17 - Carry out control of transport heli...	M09 - Landing Craft					
T18 - Constitute itself as a platform fo...	M10 - SHV					
T19 - Acting as the flagship of a Natio...	M11 - TRACSVAN					
T20 - Transport, disembark and logisti...	M12 - Operations					
T21 - Constitute itself as a platform to...	M13 - Support services					

The "Task modules and submodules" table presents the selected tasks and their respective modules and/or submodules.

Modules to be selected

MODULE
M01 - General Staff
M02.1 - EH 101
M02.2 - Lynx MK95
M03.1 - FFAS
M03.2 - IRF
M03.3 - CMF
M03.4 - BLT
M03.5 - UAV
M04.1 - AUV/DGM
M04.2 - Hyperbaric chamber
M04.3 - General diving
M05 - SEF
M06 - ANPC
M07 - Army
M08.1 - Medical First Echelon...
M08.2 - Medical First Expe...
M08.3 - Medical Second Ec...
M09 - Landing Craft
M10 - SHV
M11 - TRACSVAN
M12 - Operations
M13 - Support services

The "Modules to be selected" table shows the modules and submodules associated with the selected tasks and will serve as a guide for their selection.

Staff numbers by module selected

Módulo de Linha	Sum of OFFICERS	Sum of SERGEANTS	Sum of RATINGS	Sum of CIVILIANS
M01 - General Staff	6	14	1	
M02.1 - Eh 101	8	13	8	
M02.2 - IRF	5	19	93	
M04.1 - AUV/DGM	2	4	4	
M04.2 - Hyperbaric chamber	1	2	1	
M05 - ANPC				
M06 - ANPC				
M07 - Army				
M08.1 - Medical First Echelon	20	8	14	
M09 - Landing Craft	0	0	16	
M12 - Operations	1	7	23	
M13 - Support services	0	0	6	

The table "Staff numbers by module selected" indicates the modules and submodules required, from which the staff numbers will be retrieved.

Totals

Officers	43
Sergeants	67
Ratings	166
Civilians	265
Total to embark*	649

≤ 808

Totals and subtotals to embark by category.

*Numbers of base crew are considered

Figure 5 – Diagram illustrating the use of the spreadsheet

Source: (Author, 2016).

In addition to choosing the suitable modules/sub-modules, and in order to obtain all the capabilities necessary to perform a set of tasks, the DOTMLPPII components to be integrated must be taken into account, namely material, training, and the interoperability of the modules/submodules with the base crew; however, this falls outside the scope of this study.

Conclusions

This study aimed to analyse the best way to organise the crew of an LPD, specifically in terms of personnel numbers, according to the mission requirements. In order to structure the work, a GO was established, which was divided into four SO, one RQ and three SQ.

The first SQ focused on the concept of employment and mission types that can be performed by an LPD; in the second chapter, based on the main doctrinal and operational documents and on the amendment proposals to those documents currently awaiting approval, it was possible to identify the spectrum of missions that this ship is expected to accomplish, as well as its OR, which enabled the definition of the modules that will complement the base crew according to the mission that must be performed.

The missions identified have shown that this type of vessel is able to perform a wide range of tasks aside from its force projection capability, and thus has multirole characteristics. However, the Marine Corps will participate in the vast majority of missions, therefore it is important to include not only the BLT but also consider its subdivision into different types of forces: the IRE, the FPAS and the CMF, which will be distributed by four different submodules that will contribute to the accomplishment of practically the whole spectrum of tasks assigned to the ship.

The second SQ aimed to characterise the organisation of the LPD crews of foreign navies. An analysis has been conducted of two Spanish Navy LPD, the *Galicia* and the *Castilla*, which focused on two missions of different types, wherein it was possible to verify that these LPD are also organised by modules, embarking extra crew members should the mission require it. Their crews comprise about 190 elements distributed by command and divided into four departments, similar to the organisation implemented in the Portuguese Navy frigates.

The Dutch Navy LPD have also been analysed, and it was possible to verify that, depending on the doctrine and organisation of the different navies, similar ships can have very different crew numbers carrying out the same type of missions.

The third and last SQ aimed to identify the entities whose capabilities can contribute to the accomplishment of a mission. Like the Marines, other military forces or civilian entities, national or foreign, may be embarked, namely on missions that entail force projection, support and logistic sustainment of the land force, either in military operations or in support to complex emergency scenarios. Therefore, the study considered scenarios where the Army, the SEF and the ANPC act as entities external to the Navy, wherein each constitutes a module, in addition to others that may require maritime transport and the use of Air Force EH 101 helicopters.

This base crew will guarantee the operation and maintenance of critical equipment, ensuring safe navigation, as well as respond effectively to internal emergency situations related to damage limitation and first echelon maintenance that arise from operating and steering the platform. However, this crew is not sufficient to operate a large part of the equipment, and more elements will have to be added depending on the specific requirements of the ship, namely the repair and maintenance of the various equipment.

In addition to the operations department, for which a specific module has been designed, the other departments in the Spanish ships have higher staff numbers; however, as their composition is highly dependent on the ship's structure and equipment, especially in the case of the propulsion and energy and weapons and electronics departments, they were not considered modules for the purposes of this study. However, the vessels analysed have provided a general idea of their numbers.

The different modules/submodules to be embarked must take into account the ship's accommodation capacity, and individual modules/submodules may embark with all or part of their capabilities, or in a combination of several modules/submodules, even if they serve the same purpose, complementing each other.

Once the modules/submodules had been identified, they were linked to the different tasks that can be performed by an LPD, and a list was compiled of the modules required for each task.

The number of personnel embarked can be considerable, thus it is extremely important to know those numbers in advance so that their organisation on board can be determined. Thus, in order to facilitate the planning process, a support tool has been developed to generate the numbers required to carry out a given set of tasks, whereby it will be possible to combine the various modules/submodules, as well as organise the accommodation, food, and scheduling requirements and determine whether there is the need to embark additional members to provide support services.

This study made it possible to answer the research question by answering the subsidiary questions and by meeting the objectives established, and to verify that the modular concept can be used to reconfigure an LPD crew for a specific type of mission or task, providing the necessary conditions to perform it and optimising its organisation.

The human resources that comprise the modules/sub-modules analysed are not themselves critical elements to accomplish the missions. In addition to their personnel, these modules will also include material and equipment, without which the tasks cannot be performed.

The present research did not include material assets, and only the personnel numbers for each module/submodule have been considered. However, the equipment and its accessories also take up room on the ship, and may even compromise the accommodation capacity.

Furthermore, and bearing in mind that using a capability requires proper training, it is also important to consider the training cycle, its integration with the modules/submodules, and the proficiency that must be achieved until the ship is declared ready to carry out a given mission.

Therefore, future research should consider the potential impact of material resources on the decision to embark a module/submodule, as well as on the actual performance of the mission and on crew training and integration requirements, in compliance with the other components that define a capability.

Moreover, the structure of the base crew must be reviewed so that it can meet the requirements of the ship that will be acquired, or new modules must be devised to bridge potential gaps.

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