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Introduction

The Exploration and Production (E&P) operations of the petroleum industry are composed of activities like geophysical surveying, exploratory drilling, development of the field, structure installation, production and abandonment (Kaiser, 2010). E&P operations can be onshore or offshore. These are supported by a logistics and service system, which requires a large variety of specialized vessels, helicopters, ports, airports, warehouses, trucks and many other components. These offshore support activities can be divided into two categories: logistics and services. This study is focused on the transportation of deck cargo to the offshore units. This was analyzed empirically and some aspects which could be improved were identified. A different service policy was proposed and a computational model to simulate this was built. The feasibility of reducing the lead time and fleet size was identified.

In Brazil, offshore oil production began in 1977 in the Enchova field, located in the Campos Basin, with 10 thousand barrels per day (Petrobras, 2012a). Nowadays, the total Brazilian production is around 2.6 million barrels of oil equivalent per day and 78% comes from the offshore fields of the Campos Basin (data from February 2012, see Table 1.1 and Figure 1.1 for the daily production per basin). The fields operated by Petrobras produce 91.7% of the total amount (ANP, 2012). This data highlights the importance of the Campos Basin and of Petrobras in the Brazilian scenario and thus the importance of the E&P logistics to support the offshore units of this basin, which is the largest in Brazil.

1.1 Relevance

The transportation of deck cargo in the Campos Basin involves around 650 thousand tonnes per year and uses a large fleet of specialized vessels. In addition, the main customers of the offshore logistics system are offshore drilling and production units and many special vessels, like those which install pipelines. The cost of the offshore operations and the value of the production are high, therefore these activities should not be interrupted due to cargo delays. Furthermore, the logistics system needs to be prepared for emergencies,

Table 1.1: Daily Brazilian production per basin in February 2012, in barrels of oil equivalent (ANP, 2012).

Basin	Total production (boe/day)	Onshore	Offshore
Campos	2,056,631		x
Santos	140,936		x
Solimões	102,844	x	
Espírito Santo	85,175	x	x
Potiguar	70,549	x	x
Sergipe	57,970	x	x
Recôncavo	57,250	x	
Camamu	33,676	x	x
Alagoas	14,653	x	x
Ceará	6,985	x	x
Tucano Sul	468	x	
Total	2,627,137		

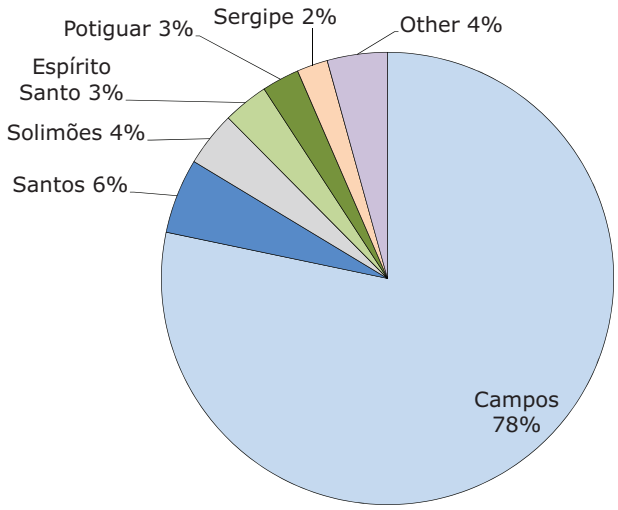

Figure 1.1: Composition of the Brazilian production of oil and gas in February 2012

as unexpected events on offshore units are frequent and they may change the cargo needs, especially in drilling units. Thus, the offshore logistics system needs to be efficient and robust.

In addition, few studies have addressed offshore logistics systems in the academic literature, as previously observed by other authors (Kaiser, 2010; Kaiser and Snyder, 2010; Aas *et al.*, 2009). In fact, although many people have gained an insight into this issue empirically, the knowledge gained in the academic arena is still in its early stages.

1.2 Outline of objectives and research

The aim of this research was to investigate the feasibility of improving the operations involving the transportation of deck cargo to the offshore units of the Campos Basin.

The specific goals are:

- to analyze empirically the transport of deck cargo
- to propose different service policies for the Campos Basin
- to investigate whether different service policies affect the robustness of the offshore logistics system
- to increase and register knowledge on offshore logistics

The research considers the fields operated by Petrobras in the Campos Basin. Only deck cargo will be considered, and only load and backload (transshipment between offshore units will be excluded).

1.3 Methodology

In this study, the service policy and the schedule of the vessels in the Campos Basin in 2011 was described. In order to identify some aspects which could be improved, a large quantity of data was collected and an empirical data analysis of the maritime operations was carried out. Thereafter, some considerations that should be taken into account to improve the service policy of Petrobras was presented. These considerations were collected from the academic literature, from the empirical experience of the personnel who conduct operations and from research carried out by Petrobras.

A simulation was carried out using the same data considered in the empirical analysis. The real cargo demand was used and different routes were created to meet this demand, making it possible to ascertain how the logistic system would have behaved if a different policy had been used. It is not the aim of this study to find the best schedule or best routes, but to investigate the service policies. Thus, a simple and easy clusterization method was chosen, that is, the Clarke and Wright method (Clarke and Wright, 1963). According to the results of the Clarke and Wright method and the desired frequency for each cluster, a new timetable was created. The historical demand of the offshore units was allocated to each trip on the timetable. According to the demand for each trip, berth and vessel availability, a simulation to determine the mean transport time between the port and the offshore units, the fleet size and composition, the number of berths and other parameters was performed.

1.4 Structure of this thesis

This thesis is presented as follows:

Chapter 1: Introduction

Chapter 2: Literature Review The literature on offshore logistics system is discussed.

Chapter 3: Offshore logistics system to support exploration and production operations A general view of the offshore logistics will be given by describing the customers, the typical cargo, the logistics system, the vessels and ports, the deck cargo composition, the demand uncertainty and the productivity measurement techniques. Also, a brief overview of the offshore logistics in Brazil operated by Petrobras will be provided.

Chapter 4: An empirical analysis The service policy and the schedule of the vessels in the Campos Basin in 2011 will be described. In order to identify some aspects which can be improved, an empirical data analysis from the maritime operations will be carried out and an example will be included. A comparison between the Campos Basin, the Santos Basin, a schedule presented by Halvorsen-Weare and Faberholt (2011) and two of the cases presented by Kaiser and Snyder (2010) will be given.

Chapter 5 : A service policy will be proposed and a method to simulate the main points of the policy will be presented. Simulation will be carried out using the same data considered in the empirical analysis and scenarios and the results will be discussed.

Chapter 6: Conclusions and future work