Factors that affect reliability in operation of loading arms of a brazilian petrochemical industry

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Abstract
This article aims to identify the factors that affect reliability in operation of loading arms of a Brazilian petrochemical industry. A research was developed to respond whether and how much operators and maintenance technicians are focused on the reliability process.

Keywords: Petrochemical Industry, Loading Arms, Reliability

Introduction

The petrochemical sector of developing countries, as the case of Brazil, has achieved in recent years a leading part in international politics, among other things, because of its excellence in the production of hydrocarbons for energy generation, such as ethanol and the importance in the projection of reserve volumes of oil fields in the Santos Basin (Hage 2012).

It is expected a country with innovative technologies with higher added value , which according to Arbix, De Negri, Vermulm (2012), Brazil is capable of achieving through, among other assumptions , a new level as an energy power based on the pre-salt operating a new benchmark in its line development.

In addition, the company has studied the growth prospect of nearly 3% per year of the demand of oil derivatives market in the country by the year 2020 as shown in Figure 1.

In this sense, business expansion is aligned with the implementation of new loading and unloading centers in the petrochemical terminal company that is directly reflected in pipeline transportation logistics and hence the strategic role of the loading arms.

This work focuses on the equipment called loading arms (LA) of a Brazilian petrochemical industry, equipment used in one of the main activities of the transport of liquid hydrocarbons and their derivatives.

The LA is part of a strategic program adequacy of reliability and operational safety for oil supply to refining and product distribution industries.

This study also contributes to meet strategic goals for the company, and according to the objectives goals of the strategic plan, by 2030 there should be improvements in operational and safety conditions of terminals and equipment structure in the studied company.

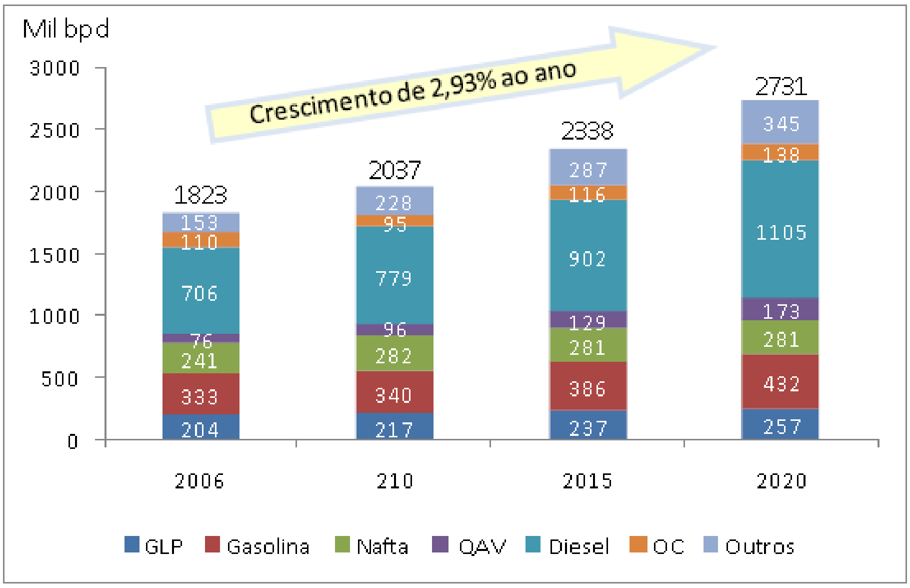

Figure 1. Market share of hydrocarbons
Source: Company adapted by author

In the end, this research identified the primary factors that affect the operations of the loading arms and it could be the start of a more expansive project that proved to be operationally efficient and effective, bringing positive results for all stakeholders.

Literature review

To answer the research question and achieve this research's goal, operations management concepts need to be understood as applied in this case study. Therefore, this section addresses concepts of operations management strategy and its impact in the operations management directing the focus on the aspects of loading arm equipment.

Operations management strategy

Globalization puts constant pressure on companies to improve their performance in operations in terms of product and services. In order to achieve improvements in products and services, companies must integrate their operations strategies, while maintaining the quality of production, reaching operating cost goals, and operating world-class processes. Operations strategy process model involves basically project, planning and control and improvement that work in a continuous cycle aligned with their competitive position in market and providing goods and services according customer requirements (Slack et al 2008).

According to Correa and Correa (2013), the continuous operations cycle demand resources and competencies to provide operational performance to, at least compete with concurrence in five dimensions: quality, costs, flexibility, speed and reliability.

For the studied petrochemical company, performance indicators used in evaluating their operations strategy is related to costs, reliability and safety. Safety should be considered as both safety and environmental because the operations of petrochemical companies are analyzed according to their impact on the surrounding environment.

Petrochemical company operations deal with reliability in terms of having the operational equipment available in the right time, responding in a same level of performance during any given period.

In this context, loading arms (LA) is defined as pipelines that are responsible to transfer liquid hydrocarbons from the ship cargo to the storage tanks using pumping equipment. According to Sastry and Seekumar (2012), LA is a system of articulated pipes used to transfer liquids - in this case, oil and oil products – from the tanks of ships or cargo ships to storage tanks of the company's terminal. The equipment is basically designed and manufactured in accordance with the norms and standards of complementary projects according to Oil Companies International Marine Forum (OCIMF 1999).

Since BC is connected to the ship's tank flange as Figure 2 below, the arm is free to follow the natural movement of the ship moored to the cradle, as shown in figure 2.

Figure 2 – Loading arm in operation
Source: FMC (2014)

LA is hydraulically controlled via control unit, in the control operator house, or remotely via a mobile unit - joystick – battery loaded. The main components of LA are base riser, inboard arm, outboard arm, mobile connectors called style and valves according to their function, as shown in Figure 3.

Loading arm and definition of research limits

According to Santos et al. (2009), pipelines and loading arms are a clean alternative form of transportation not subject to traffic congestion and a relatively inexpensive means of transportation for liquid hydrocarbons and safer derivatives worldwide.

Nevertheless, operating pipelines represents significant risks to the environment. Several accidents, in Brazil and around the world, involving the release of toxic or flammable substances have had a serious environmental impact on flora and fauna, as well as deaths and damage to the health of populations in the vicinity of pipelines. This has led the countries involved to increase environmental requirements relating to the operation and maintenance of pipelines transporting hydrocarbons.

Considering that LA at all stages of its production process, has the potential to have an impact on the environment and the health of people in surrounding areas—in particular, their workers, depending on specific risks in their workplace (Augusto 1991). In addition, it is needed to define its research limits of the pipeline transportation system because our research's goal is the LA itself, not the entire system. For this reason, the research is limited not exclusively as shown in figure 3.

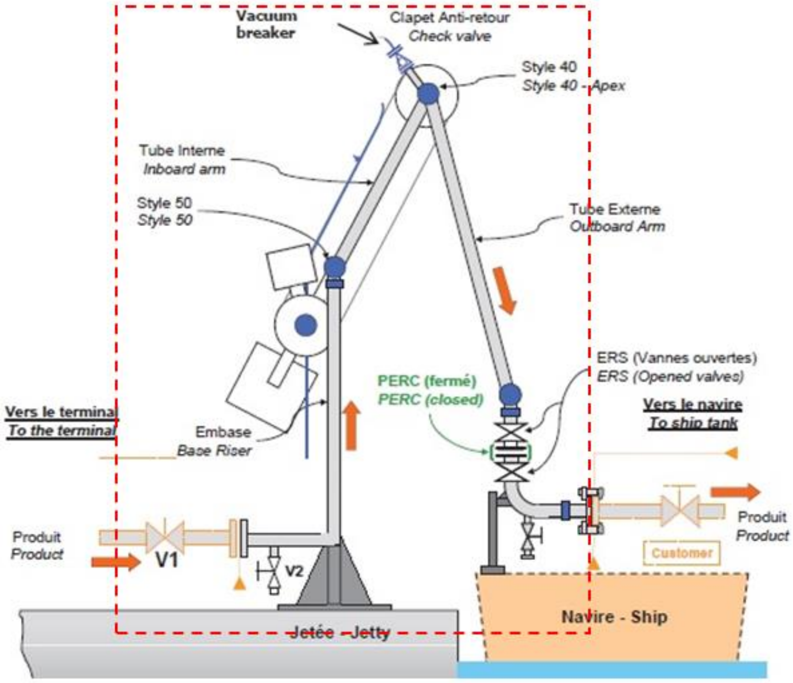

Figure 3 – Load arm and research limits
Source: Company (2014)

Methodology

The method used was a case study in a Brazilian petrochemical industry. The choice of carrying out a case study was justified by the fact that the overall objective of the research involved operational issues that needed to be investigated over time, rather than being seen as isolated events or incidents. Furthermore, a case study is the most recommended strategy when examining contemporary events and when doing research that cannot handle all the relevant behaviors to be studied or ignore the context in which they occurred (Yin 2005).

Literature searches are developed on the subject to know the work carried out and prevailing opinions on the subject (Marconi and Lakatos 1990). Thus, despite the lack of data available on the loading arms, was possible to understand the substantial needs and influences that motivated companies to study impact factors in the operational outlook and reliability.

Marconi and Lakatos (1990) also state that the literature is how to help explain a problem starting from theoretical references published in different academic studies, such as articles, theses, dissertations, among others, but it is required that one be held literature previously articulated to the subject being studied.

In the first step, a literature search was done in order to identify theoretical approaches to operations management strategy, loading arms to reliability perspectives. Among fifty workers in operations, three operators and two maintenance technicians are selected to respond a survey. Sampling by convenience and semi structured performed between May 10 and June 25, 2014. Data manipulated under non probabilistic method.

Results in percentage shown as in table 1 and 2. Questions performed in the survey according Slack et al (2008).

Table 1 – Questions for operators

Item	Question
1	Function operational with LA is clearly defined and understood by operators?

2	Do operators understand the processes with LA - inputs, activities and outputs?
3	Continuos Improvement and innovation with LA is developed ?
4	Differences between LA differents processes in terms of volume, variety, variation and visibility is understood?
5	Recycle in terms of quality concepts is performed with operators?

Table 2 – Questions for maintenance technicians

Item	Question
1	Failure data of LA is feeded into failure management system database?
2	Failure impact of LA and its symptons are tracked and followed using any methodoly?
3	FMEA for LA are used?
4	LA repair procedures are updated?
5	LA Critical and systemic failures are shared among different teams in different plants?
6	Multifunctional teams do participate in corrective and preventive actions of LA?
7	Does the company use modern technologies to perform predictive maintenance of LA?

Analyses and results

Results found in the field research are presented in table 3 and operators understand the function of loading arms as part of business strategy and they also use operational standards and all data related to the check list and control for inputs and outputs of the basic process like "conect LA", "load or unload cargos". In addition, continuous learning culture by sharing information and lessons learned can be used as a powerful tool with fast response in terms of doubts, ideas interchange and people integration. This happens frequently when teams meet supervisors and coordinators during shift change.

Table 3 – Survey with operators

Question	A	B	C
Function operational with LA is clearly defined and understood by operators?	85	70	60
Do operators understand the processes with LA - inputs, activities and outputs?	70	80	50
Continuos improvement and innovation with LA is developed ?	30	30	10
Differences between LA differents processes in terms of volume, variety, variation and visibility is understood?	100	100	100

Recycle in terms of quality concepts is performed with operators?	80	70	50

Field research found as shown in table 4 that maintenance technicians along with interviews that the history of anomalies and failures, as well as their treatment and prevention lost focus on the maintenance management system. There seems to be that the company only invested resources and people in higher-impact failures and in the critical equipment. The technicians pointed out that successive budget cut-offs that downsized third party contracts and voluntary lay-offs impacted maintenance operations.

Table 4 – Survey with technicians

Question	**D**	**E**
Failure data of LA is feeded into failure management system database?	25	30
Failure impact of LA and its symptons are tracked and followed using any methodoly?	25	30
FMEA for LA are used?	25	30
LA repair procedures are updated?	50	50
LA Critical and systemic failures are shared among different teams in different plants?	40	50
Multifunctional teams do participate in corrective and preventive actions of LA?	60	70
Does the company use modern technologies to perform predictive maintenance of LA?	60	60

Conclusion

Our research's goal to define factors in operation of loading arms that affect reliability showed that company operations deal with reliability in terms of having the operational equipment available in the right time, responding in a same level of performance during any given period. In this context, the company has different performance indicators for loading arms and, the most important metrics are: efficiency of cargo loading; equipment operational availability and number of preventive and corrective actions.

In despite of lower performance, a performed survey with workers showed that continous improvement and innovation practices with the loading arm manufacturer are key factors to keep higher motivation and better result orientation for operations management. Under maintenance perspective, the concern is the lack of information in the maintenance management system for the loading arms. Failure hystorical and corrective and preventive actions are not feeded and updated. Problem solution practices are restricted to major issues only.

With the primary factors identified and their solution plan organized, implemented and continuously improved, a new standard of operational procedure could be established that reinforces the need for management of control. This contributes to the maximization of loading arms operation, reduction of corrective intervention in equipment and higher LA availability.

In addition, the company can respect its principles of operational excellence, reducing any potential risk with its loading arm. Moreover, LA reliability directly affects operational quality, reducing their impact on the environment, workers' health, and the organizational climate. This aligns with the strategy of sustainability and respects the interests of stakeholders in the industry.

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