Opportunities of study that allow the improvement of the Integrated Management Plan

The Case Study of Brisa

Edgar Faísca

Department of Engineering and Management, Instituto Superior Técnico

Abstract

The objective of this work is to study the occurrence of failure at Brisa's toll facilities, in order to gather information about its causes and motivations, to increase their knowledge, and thus facilitate the taking of measures to improve the effectiveness of the operations management.

In the competitive environment in which we live is crucial to be efficient in the allocation and asset management in order to meet the high expectations of customers at the lowest possible cost. Maintenance operations are characterized by a random component that complicates the planning activity, and requires the decision-making that usually follows a cost increase trend for a decrease in randomness, usually distinguished by its purpose as planned and unplanned maintenance. This paper is focused on the South motorway to study the feasibility of a solution on the planning of maintenance operations, based on the analysis and modelling of historical data on the failure behaviour of components in the past. Thus, it will be understood in a first phase the fault behaviour in toll infrastructure and verified possible reasons for the same. From this analysis, it will be selected the system with the highest incidence rate of failure, from which will be developed the case study. This system will be analysed in terms of its architecture, operating mode and pattern of failure in order to understand their needs in terms of maintenance, and what drives those needs. The last phase involves the development of a suitable forecasting model specific to the demand behaviour of each subsystem. Finally, we will elaborate a suggestion for the theoretically ideal location storage subsystems and components that have been found demanded in the past

Keywords: Maintenance; Forecasting Methodologies; Spare Parts; Integrated Management

1. Introduction

In this new century we live in, the change is no longer a slow and predictable process, becoming a phenomenon of the day-to-day, instant and unpredictable, able to catch unawares any organization, regardless of size, position or reputation. This paradigm shift leads to the emergence of new challenges and opportunities, whose use is based on three key skills. The ability to innovate, flexibility and cost control. Its importance is such that it cannot be considered as a competitive advantage, but rather obligatory condition for any player of the markets in the XXI century. On the one hand, flexibility and innovation arise as a way to track, understand and anticipate the future in a value creation perspective, focuses mainly on cost control implementation of all these activities with the greatest possible operational efficiency of the form free resources for the activities and projects that create added value. It is precisely within the efficient management of assets that arises this thesis, developed in partnership with Brisa Innovation and Technology (BIT).

Brisa being an operator of motorways internationally, and the national transport infrastructure, naturally arises the need to study continue on ways to better manage their fixed assets, maximizing the service level and minimizing associated costs.

In this case study, it is intended in the first instance to understand the maintenance needs of systems and toll equipment. Later quantifies them and study the causes that determine them. The last phase concerns the development of a forecasting model of adequate demand to the specificities of subsystems, which are classified according to their performance on three criteria. From this classification, storage location is suggested that best suits their individual characteristics.

2. Objectives

The aim of this work is the study of failure behaviour of systems present in Brisa toll facility. The aim of this study contribute to increased knowledge on the occurrence of failure and its causes, increase the efficiency of maintenance operations, thus contributing to better planning and potential cost reduction in the scope of operational logistics, maintaining or ideally rising the service level threshold.

To achieve this goal, the work will focus primarily on three subjects, for which the following objectives are defined:

First, we intend to analyse the failure behaviour that occurred in the past, quantifies it and set its evolution throughout the history analysis. To understand whether there is any trend in its evolution over time, their dispersion about the different types of existing via the A2 motorway and system ID that contributes most to the occurrence of flaws in the toll plazas. This system will be drawn up case study in order to understand the main motivations of the occurrence of failure, and thus gather information that can contribute to improving the efficiency and effectiveness of maintenance.

Later it will study the demand for maintenance materials. The historical data from the past four years in order to understand whether there are patterns and correlations to improve the forecasts of needs of some critical components will be analysed here. The goal then passes to associate the demand forecasting model that best fits each of these subsystems by creating a prediction model for each search pattern identified. These prediction models use the A2 highway as a prototype, but will be prepared so that they can be scalable to any highway.

Finally, ways to determine the classification of maintenance components will be analysed. With this classification is intended to set priorities among components and subsystems, aggregates them into clusters according to their performance on certain criteria, and according to their performance, prepare suggestions for the storage location that best suits your needs

3. Structure of the Problem

Brisa supports the conduct of its activities in a number of infrastructure and equipment that have maintenance needs. It is therefore essential to efficient management of these devices in order to achieve a positive balance between maintenance costs, inventory costs and level of service provided to the customer.

Maintenance costs include costs for each repair costs and having the components and equipment necessary for each repair available, these being the greater the higher the required availability for each component. Usually have a fixed cost component that includes the equipment and human resources necessary for the maintenance activity, and a variable component, which depends on the needs of maintenance of components in each period. This variability is explained by the unpredictability of the failure of some components due to factors that vary over time and are usually difficult to predict with accuracy. It is exactly the variability in equipment failure that leads to the need of inventory constitution, and consequent increase in costs.

In order to reduce variability may follow two paths: may be applied to preventive maintenance, which somehow turns the maintenance activity at a fixed cost and therefore planned, which is good, but expensive, and therefore should be assessed case by case. On the other hand, or in addition, historical data relating to the maintenance of each equipment needs can be analysed in order to identify patterns of demand and causal relationships that can allow to understand more accurately the when, the how, and why of each fault, and thus to predict future needs maintenance components for each equipment, thus allowing the planning, which is usually synonymous with reducing costs and efficiency in the management of materials. It is required then a case by case basis, it is probable that in more variable situations you can think of a hybrid approach, that is, applying the methods of forecasting, analysing their distribution, to further include a preventative maintenance solution in times of greater uncertainty. The decision will be made on the basis of cost / benefit.

Each fault has associated with it a certain impact on the customer, which is reflected in an impact also on the breeze. The BIT maintaining the value chain includes maintenance of vehicles and proximity stores, each with a certain ability to inventory, which aim to increase the level of customer service, from a greater availability of inventory and its proximity to the problem. Thus, for each component will be allocated a representative classification of the impact, and this impact will be greater the greater the exposure fails to customer perception. To ensure that no fault with a high degree of customer exposure is prolonged in time, the most appropriate location will study the storage of component maintenance, to ensure the appropriate level of service.

Broadly, can be defined the problem presented by BIT as a need to improve management of the integrated plan. The integrated plan is in this case composed of the entire value chain integrating maintenance activity. After studying the operation of the integrated plan, they identified the problems related to the unpredictability of the needs for some maintenance components, and the need to understand the causes that justify it.

Being a complex problem arises the need to divide it into 3 parts:

The first step relates to the understanding of BIT reality. Thus, the focus was on knowledge of people, the way we work, equipment that support the activity, and especially the values that are part of the company culture.

The second phase consists of the study of how to create forecasting models appropriate to the specific characteristics of the service components. To this end, it studied the reason justifying the need to predict the demand for each component. It understood that each component has specific characteristics that define it, and that adding these features data on looking for you in the past, you can set your default search, and understand the reasons for this pattern.

Finally, it was made a review of the state of the art relating to forecasting models and selected a prediction model for each type of time series.

The third and last phase is realizing how more accurate predictions can be used to provide improved possibilities to level inventory management. Now, after application of the forecasting methods and obtained the new values of demand for each component, and bearing in mind the impossibility of building inventory of all components, there is a need to set priorities. To make these decisions consciously and consistently, they were reviewed ways of identifying and classifying components.

4. Clarification of the database and Nomenclature

The study of the occurrence of faults in the toll facility requires the acquisition of knowledge regarding the toll facility in maintenance Breeze, therefore, it was necessary initially to quantify and qualify each failure. For this reason, it is crucial to be clear right away the nomenclature used.

Work orders (OT) occur whenever it is necessary to intervene on any system, regardless of whether or not a failure, or even the type of maintenance work that triggers. On the other hand, maintenance events (MS) are generated when a fault occurs whose resolution requires a replacement or a repair operation. When there is a failure, the resolution of which generates demand for component maintenance, that is, all replacement and only part of the repair work operations, we have a maintenance and substitution event (ES).

All the OT therefore contains all occurrences recorded in the A2 motorway. After the analysis will determine the ratio of T corresponding to ON, which will be further analysed in order to quantify the proportion thereof that correspond to ES. At a later stage of this study, a detailed analysis of each of the ES will be made, in order to understand the motivations of each one of them. The reason which led to failure, is given the name of trigger, regardless of whether it is a component or a particular adverse operating condition.

The basis on which this study comes from a set of data provided by Brisa:

Database of the work orders generated in the A2 motorway in the period from June 1 2011 to May 31, 2015, which corresponds to 48 periods, it is considered that each month is equivalent to a period.

Database on the volume of traffic checked at each toll plaza over the years 2011, 2012, 2013, 2014, 2015.

The same analysis was demanding insofar as the description of work orders is performed by the maintenance staff responsible for its resolution, a fact which leads to significant discrepancies in how they describe the same intervention. Thus demanded initially understanding its layout and organization, then the filtering, and finally a semantic analysis was conducted, from which extracted relevant information that was reorganized under a new provision based on standardized descriptions that allowed their operation in greater detail.

5. Case Study

The aim of this work was to gather information on the occurrence of failure in the systems that belong to the toll infrastructure of Brisa, and analyse it in order to draw conclusions about its causes, and thus allow the Brisa to see there maintenance operation from another point of view. It is also intended to set up proper forecasting model the characteristics of demand for replacement components and by setting performance criteria for these components, evaluate them and prioritize them in order to prepare a suggestion for the location of storage.

In this sense, it started by the classification and characterization of the maintenance operation throughout history. Were defined nine classes:

1. Upgrade: Hand labour
2. Replacement: Hand labour, maintenance of components and availability
3. Repair: Hand labour and availability
4. Reboot: Worker availability
5. Cleaning: Hand labour and availability
6. Update: Hand labour
7. Analysis: Hand labour and availability
8. Foreign Intervention: It does not involve needs
9. Pitch: Hand labour and availability

And then, analysed the OT according to the weight of each class, is getting to know the repair work, replacement and reboot absorb 90% of total generated OT, with the remaining 10% shared by the other 6 classes, unimportant, since they have little impact on the maintenance and operating together with the reset operations represent the classes that do not involve searches for service components. It was also studied the dispersion of it, function in OT of different types of channels, concluding that the VMSA kind of way were those that caused more OT, accounting for 60% of its total value. Since the study focuses on understanding the maintenance requirements, it was made a first approach to EM. The approach was based on a study of the time series from which we realize that are characterized by randomness as regards the quantity and time in which they occur. Also we realize that there is a slight downward trend, boosted by improvements in equipment have allowed improve the performance of systems. Once we understood the size of the infrastructure and the diversity of subsystems involved, we felt the need to select a system on which guide the study. Thus, there was an examination of each system to the representation on the occurrence of ES, from which it was found that the distribution follows a heterogeneous pattern. This demonstrates that different systems corresponding to different maintenance requirements which according to the checked dispersion demonstrated to correlate with the technological complexity of each. There are common system all tracks, and there are also specific systems for certain types of route, and the analysis showed that there was a single system responsible for 41% of the ES, the Etoll system, the ES occurrence rate was clearly higher than the other, it became apparent that this is the focus of the case study.

It denoted that depending on the time of the year and location of the toll plazas, operating conditions varied, and so they were the subject of study. Together with the BIT maintenance employees have been defined four variables affecting the operating condition of the systems and subsequently evaluated individually:

Temperature: The maximum oscillation amplitude in terms of average maximum temperatures are 6 ° C denotes that the temperature follows a seasonal pattern corresponding frequency to 9 months, and that it increases as one moves away from the sea, and therefore, the locations of Marateca, Alcacer do Sal and from Aljustrel and Paderne are those that have higher average temperatures.

Solar exposure: As the sun in the Northern Hemisphere born around the east and will put up the West, it turns out that the toll plazas whose orientation follows the sun are subject to direct sunlight, while the toll plazas oriented North / South are exposed to a side sunlight. Thus, it appears that the toll plazas of Coina PV, Palmela, Marateca and Paderne are susceptible to higher levels of sun exposure.

Precipitation: In general, the precipitation conditions are constant along the freeway A2. The area most affected by rainfall is the Tejo Valley area, which saw an average of over 10 (mm3 / month) of precipitation. From Palmela volume of precipitation is approximately constant, so that in general it can be said that the systems are exposed to rainfall equivalent conditions. Moreover, by analysing the levels of rainfall during the year, it denotes that is characterized by a locally stationary pattern, so there are natural variability on the period in which most rainfall, but it was found that the month of November, December and April correspond to periods where it is more likely to occur higher levels of precipitation.

Traffic volume: Use the highway follows a seasonal pattern U-shaped, with peak recorded in July of each year, showing a peak frequency equal to 12 months. The month where there is less traffic volume is between December and January, which together with the months of October, November and February represent the pits. From the latter, followed by a gradual and linear increase boosted by Easter, which supports the increased traffic before the start of the warm periods traditionally characterized by a strong influx of drivers to the South of the country area. The volume of traffic is more dense and regular in the area of Lisbon and Tagus Valley, as it is utilized by tens of thousands of vehicles to move from Lisbon to the South Rim and vice versa. Moreover, traffic between the recorded area and Marateca to Paderne checks a more marked seasonality profile. Due essentially to the Easter and especially the summer. We conclude that there is a positive and strong correlation between the volume of traffic and the occurrence of OT (R^2 = 0599). On the other hand, when the traffic volume associated with the occurrence of EM indicates that the correlation coefficient is very expressive (R^2= 0.168). This demonstrates that unlike the OT population, the population of EM does not check a dependent relationship of the volume of traffic.

After understanding the failure occurrence on the toll facility and the definition of operating conditions that could impact their behaviour has been the study for the detailed analysis of Etoll oriented system. Since it is a young system (operating at about five years) and technologically complex, it was first set up your architecture into modules according to their functionality in order to subsequently analyse the occurrence of failures in each of the modules individually. For the occurrence of ES, it was concluded that it is not possible to identify a standard seasonal or even a trend, and when analysing the evolution of the number of repair, replacement, it turns out that the BIT has been to alter its operational strategy, in that the number of repair operations are less and less, whereas replacement operations have increased progressively. Since every failure is associated with a particular impact on the road, it was also studied this factor, concluding that 95% of ES there are implications for the client so that give rise to a decrease in the level of service. Yet, only 27% of cases the cutting means is necessary.

In order to understand if there modules in Etoll that contributed most to their failure, were individually studied subsystems belonging to their modules, and conclusions drawn about their pattern of failure and its causes, namely:

All subsystems are characterized by a locally stationary pattern, with the only difference is the amplitude of the natural variability associated with the occurrence of ES. Accordingly it is concluded that the VOIP subsystem in conjunction with the card payment sub-module are subjected to higher levels of randomness.

The frequency of replacement due to the various subsystem. In fact, it turns out that the payment by cash sub module is one that failed. This consists of three subsystems, and denotes that the acceptor notes in conjunction with the acceptor coins and cassettes, are the subsystems that contribute most to the occurrence of ES.

With regard to operating conditions, shows that its impact on this system is not very relevant, and only the payment module implies being affected by the weather. Denotes that the sub-module card payment is affected by rainfall, and the sub-module cash payment is affected by precipitation and temperature, even though they have seen little significant correlation coefficient. The fact that the failure occurred in Etoll system is not apparently linked to the volume of traffic, causes some confusion, and in that sense, it is open the possibility of the future to analyse the occurrence of failure in the subsystems based on an analysis of reliability to them.

Since the maintenance strategy focuses on component replacement instead of repair on site, it was not always possible to identify the triggers of failure. Still, it was concluded that the subsystem LIT is replaced due to wear of the O-rings, payment sub-module originates ES essentially due to the acceptor notes, and the payment in cash sub-module, which is the only subject to various operations on-site repair, generates ES mainly due to the coin acceptor whose cause of failure is usually the jammed coins.

Since all modules and subsequent subsystems checked the same search pattern, it created a non-causal basis prediction model, since it is not possible to correlate evidence of the occurrence of failures in Etoll system with any of the analysed operating condition. Was selected the exponential smoothing model because of its ability to adapt to different levels of randomness associated with each subsystem, and based on it, were prepared forecasts for the component with the highest frequency of replacement of each module.

Finally they were classified the various subsystems and components maintenance according to three criteria (failure frequency, volume and failure impact on the operational capability of the track). It was concluded that most components have low volume, low frequency of replacement and its failure does not imply saw cut. It also denotes that there are only five components of high volume and eleven frequency components above the average. It was finally allocated to the storage infrastructure that best matched to their individual characteristics, verifying that 63% of the components / subsystems were allocated to advanced warehouse, 20% to mobile warehouse and 17% to the central warehouse.

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