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Improving organizational decision support: Detection of outliers and sales prediction for a pharmaceutical distribution company

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Abstract

Stock unavailability in the supply of medicines to pharmacies can be caused by several factors including manufacturing problems, lack of raw materials, end of product selling, disease and epidemics outbreaks. Furthermore, the sale of medicines by some pharmacies to foreign markets has increased in recent years, and is considered one of the main causes of medicine supply failures in Portugal. This paper depicts the case study of a pharmaceutical distribution company in Portugal and aims to address two main research issues. The first one consisted in detecting customers (pharmacies) and products (medicines) which may be considered outliers and perform stock proration when these outliers are detected, in order to avoid abnormal sales and out-of-stocks in pharmacies. The second one targeted the sales prediction for the pharmaceutical distribution company, in order to better control and manage the levels of stock of medicines, so as to avoid excessive inventory costs while guaranteeing customer demand satisfaction, and thus decreasing the possibility of loss of customers due to stock outages. In outliers detection (customers and products) we used the Box-plot method as well as the SPSS statistical software. For sales prediction, the time series data mining method smoothed Pegels was used, while the implementation was done in SQL and the analyzed data was stored in an Oracle database.

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1. Introduction

One of the responsibilities of the wholesale distributors of medicines in Portugal is to comply with the law of having a minimum stock of medicines in order to guarantee supplies in the national market and, thus, avoid possible breakdown situations in pharmacies. According to Infarmed - National Authority for Medicines and Health Products I.P. [1], medicine stock breakdowns caused when there is no available quantity of certain medicines to satisfy the requests of customers (pharmacies), can have as origin several factors, such as: manufacturing problems, lack of raw material, end of product commercialization, disease outbreaks, epidemics, etc.

In addition to these factors, the sale of medicines by some pharmacies to foreign markets has increased in recent years and is considered to be one of the main causes of medicine supply failures in Portugal, according to news broadcasted in several media[2]. The reasons pointed out for this practice of medicine exports are the decrease in medicine prices in Portugal and the difficult financial situation of pharmacies, which have made the sale of medicines to foreign markets more and more attractive and profitable.

For the pharmaceutical distribution companies, it is therefore of prior importance to detect customers (pharmacies) and products (medicines) outliers (values that distinctly stand out or are inconsistent from others) and prorate (divide proportionally) the stock when those outliers are detected, in order to prevent the abnormal sale and to avoid stock breakdowns in pharmacies. In addition to this need, there is a gap between the periodicity of deliveries of medicines to pharmacies, which may have several deliveries per day, and the procurement of medicine stock by distributors, which can take about two days.

On the other hand, it is essential for pharmaceutical distributors to have a good forecast of the needs of medicines, due to the short-term shelf-life of many medicines and the need to control stock levels, in order to avoid excessive inventory costs as well as the loss of customers due to stock outages.

An adequate sales prediction is generally associated with achieving a good balance between inventory costs and a proper customer demand satisfaction[3]. In the specific case of the pharmaceutical distribution industry, the problem is of furthermore importance due to the short life cycle of most products and the product quality requirement, which in turn is strongly linked to public health issues[4].

This paper extends the work described in[4,5] by addressing in combination two main research issues in order to improve organizational decision making within the pharmaceutical distribution business, using the case of a pharmaceutical distribution company in Portugal. The first one consisted in detecting customers (pharmacies) and products (medicines) which may be considered outliers and perform stock proration when these outliers are detected, in order to avoid abnormal sales and out-of-stocks in pharmacies. The second one targeted the sales prediction for the pharmaceutical distribution company, in order to better control and manage the stock levels of medicines, so as to avoid excessive inventory costs while guaranteeing customer demand satisfaction, and thus decreasing the possibility of loss of customers due to stock outages.

The rest of the paper is structured as follows. In Sections 2 and 3 we provide the background on outliers' detection and data mining, so as to set the theoretical underpinning of the approach described. In Section 4 we describe the application of the approach for the case of the pharmaceutical distribution company in Portugal. Section 5 concludes with considerations on the achievements produced so far and directions for future work.

2. Data analysis and outliers detection

2.1 Outlier definition

Historical data sets may be influenced by unusual and non-repetitive events[7]: the outliers. Two types of outliers can be identified: the gross errors and the “true” outliers. The former are associated with processing errors, e.g the