Project Description
Bachelor Project

Modelling of Medicin Consumption in Hospitals

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11/02-2022

1 Project Description

Scope

Expenditures within the healthcare sector increase yearly. In Denmark, the total welfare expenditures in 2020 amounted to DKK 764 billion (before tax). While the majority of expenses are used within eldercare, the area sickness and health comes in second place with expenditures of DKK 163 billion (before tax), where 62% went to hospitals [DST, 2021b] [DST, 2021a]. The expenditure on this has increased by 54% over a period of 14 years (since 2007) [DST, 2021a]. Both the expenditures divided over areas within healthcare and the increase in expenditures are visible in Figure 1.

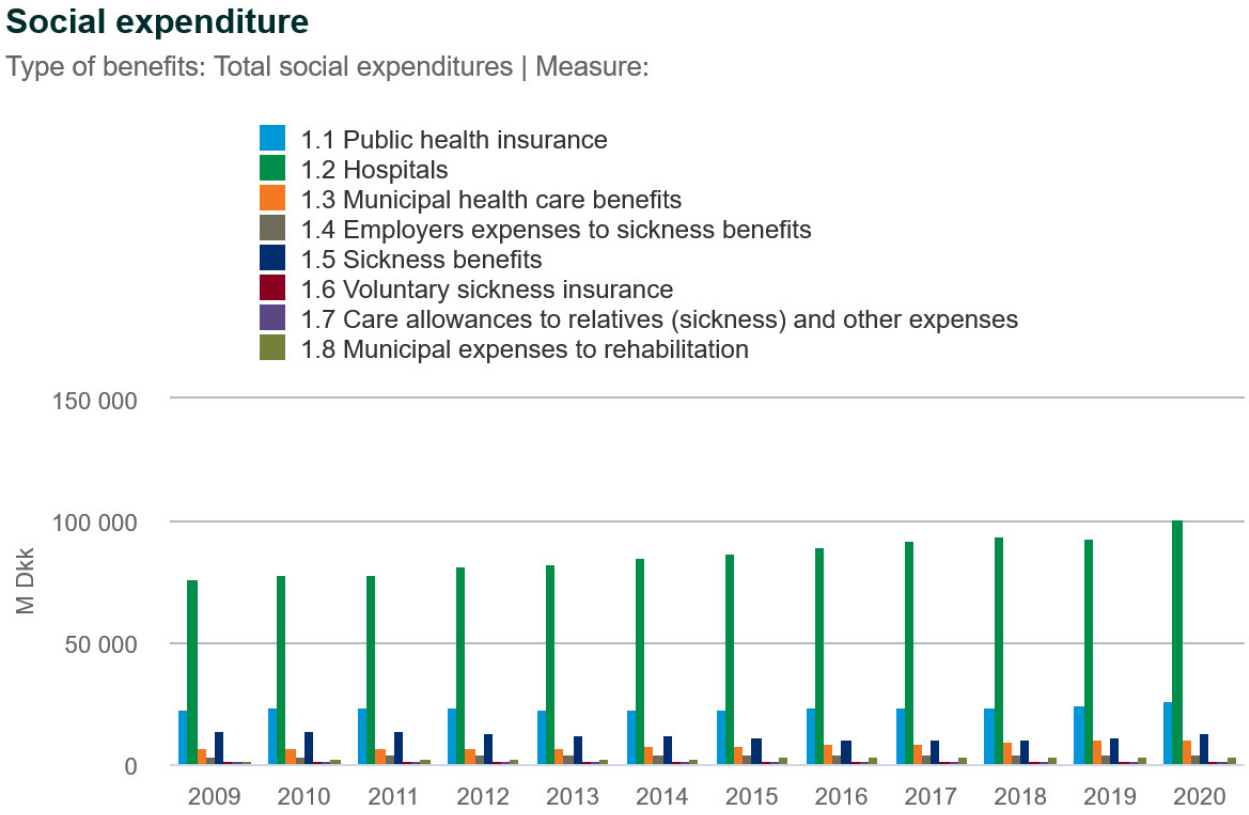

Figure 1: The expenses of the healthcare sector (the area sickness and health) from 2009-2020. The bar chart clearly shows, the large expenses of hospitals [DST, 2021a]. Note that eldercare is an individual sector, and thus not included on the figure.

Numbers from 2019 showed that DKK 9.2 billion was used on medicine [Müller, 2019]. The vast majority of expenditures for healthcare are financed by tax money. For that reason alone, it is important to have a system in place where the costs associated with medicine supplies are minimized without sacrificing the quality of patient care. A natural trade-off has been established between quality metrics (ex. service level, timely treatment, etc.) and cost [Moons et al., 2019]. Consequently, it has proven difficult to manage inventory at hospitals as there ideally is no room for mismatch between medical supply and needs; too little medicine can result in wait time for patient in need of care, while

too much medicine can result in increased costs as it is left unused and expires [Moons et al., 2019]. Yet, up to 46% of a hospital's total operating budget is spent on logistics related activities such as managing inventory [Landry and Philippe, 2004]. The current system in place at Rigshospitalet, on which our study will be based, is the two-bin kanban system. The two-bin kanban system is, quite literally, a system which applies two physical equally-sized bins in the care units to manage inventory, i.e., one bin where medicine is taken from and one reserve bin [Volland et al., 2017]. Whenever inventory levels fall below the reorder point, a refill quantity of a full bin is ordered [Volland et al., 2017]. This is a very simple and non-tech-savvy approach. Generally, healthcare is an industry affected by poor IT solutions which makes it hard to manage cause "You can't manage what you haven't measured" [Moons et al., 2019]. This study will therefore focus on the data available and the system in place and try to tweak and improve the current system. Can we somehow make the system more efficient without suggesting huge changes? We will examine whether modelling and forecasting techniques can be used to standardize some medicine supplies. If the result is a fairly stable forecasting curve and a low map (which aims to minimize the error between demand and forecasting) for a type of medicine, it is only necessary to have automatic orders for this and not waste employees' hours.

Methods

The first sub-goal of the project is to process the data properly. This has potential of being quite an extensive process, due to the use of real-life data, which often entails noisy datasets. The noisiness of the dataset can represented in multiple ways e.g. missing entries, extreme outliers, purposeless information etc. The quality of the dataset is not ideal for the scope, since the dataset was not created based on an intention of optimizing the supply chain. Therefore, the cleaning of the dataset will be substantial work.
It is necessary to gain an overview of the data to properly process it. The simplest way to do this is by visualizing the dataset. This can be done in various ways which all result in different visualizations. It would be beneficial to examine the tendencies and attributes of the data which can be done by visualizing it. The visualization of the data can accelerate conclusions of clusters, distributions, and quantity, which will benefit the project work greatly.
Both the tendencies and attributes of the dataset can also be thoroughly investigated by the use of descriptive statistics. Descriptive statistics are extremely useful both in terms of understanding the data but can also be used as a tool to determine how to proceed with the data processing. By applying an analysis of the descriptive statistics, the goal is to gain knowledge of the ordering system i.e. how often orders are placed, the review system, lead time, total usage etc. Therefore, the foundation of the project will be build upon visualization and descriptive statistics.

When the dataset has been thoroughly processed and is formatted correctly, the second sub-goal emerges. The data processing is essential and will require extensive work but is also a necessary to further evolve the optimization of the supply chain link i.e. the inventory management. The inventory management, especially the ordering process, can only be optimized when the data processing is complete. The optimization can be performed by reviewing and comparing different forecasting

models which in turn will predict the demand of medicine supplies. It is unlikely, that the extent and nature of data will allow a forecast for all the hospital's demands, but hopefully it will be possible to determine some distinct tendencies and thereby calculating a fair forecast for some of the supplies.

Data Description

The data used for this project consists of two files. The first file contains data from orders of medicine at Rigshospitalet made in 2021. The second file contains data regarding consumption of medicin at Rigshospitalet.

The order data has 11 attributes:

1. Specification of which department has ordered the medicine
2. Specification of ward
3. ATC code
4. Item number
5. Item name
6. Item strength
7. Item dosage form
8. Item package size
9. The cost
10. The Defined Daily Dose (DDD)
11. Number of packages

The consumption data has 8 attributes, making it inconsistent from the ordering data. The specific attributes of the data are

1. Specification of which the department has ordered the medicine
2. Specification of ward
3. Date and time of consumption
4. Batch number
5. Item number
6. Type of consumed medicine (includes name, strength and dosage form)
7. Consumption quantity
8. Number of consumptions

At first, it is important to note that the department names in the two files have been written differently. Therefore, it is necessary to correctly match them and make sure that they are identical. To gain knowledge of the consumption (usage) of the orders, the drugs in the two files should be comparable. However, that is not possible at the moment, since the consumption file is extremely sparse in regards to item number, making it quite difficult to compare the two files. Therefore, it will be necessary to use the string containing the type of consumed medicine and match that with the same

information in the ordering file, to find the ACT codes of the specific medicine. This will then allow us to compare the information contained in the two files.
Note that while the knowledge of the consumption quantity and number of consumptions have the appearance of being useful, the data of the two attributes do not make much sense since the number of consumptions appear to have been collected incorrectly.

References

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