MAINTENANCE PLANNING NEEDS AT SOCIÉTÉ DE TRANSPORT DE MONTRÉAL

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THE STM IN NUMBERS

32 G$
in asset replacement value

Material Assets :

Metro:
- 71 AZUR trains, each consisting in of 9 cars
- 423 MR-73 train cars (equivalent to 47 trains of 9 cars)
- 4 metro lines, 68 stations, 71 km of tracks

Bus :
- 2006 buses including :
    - 969 regular APS (15 air-conditioned),
    - 739 hybrid buses (726 air-conditioned),
    - 257 articuled buses (2 air-conditioned),
    - 41 electric buses with air-conditioning,
    - 86 minibus (TA) and 16 urban minibus.
- 224 bus routes, 440 km of routes

Reference :
https://www.stm.info/fr/a-propos/grands-projets/grands-projets-termines/trains-azur
https://www.stm.info/fr/a-propos/informations-entreprise-et-financieres/rapport-annuel-2022

THE STM IN NUMBERS

1,5G$
yearly budget

Human Resources:

Employees :
- 10 775 employees
- Over 500 different jobs in the organization

30M$
inventory value

Maintenance Buildings:

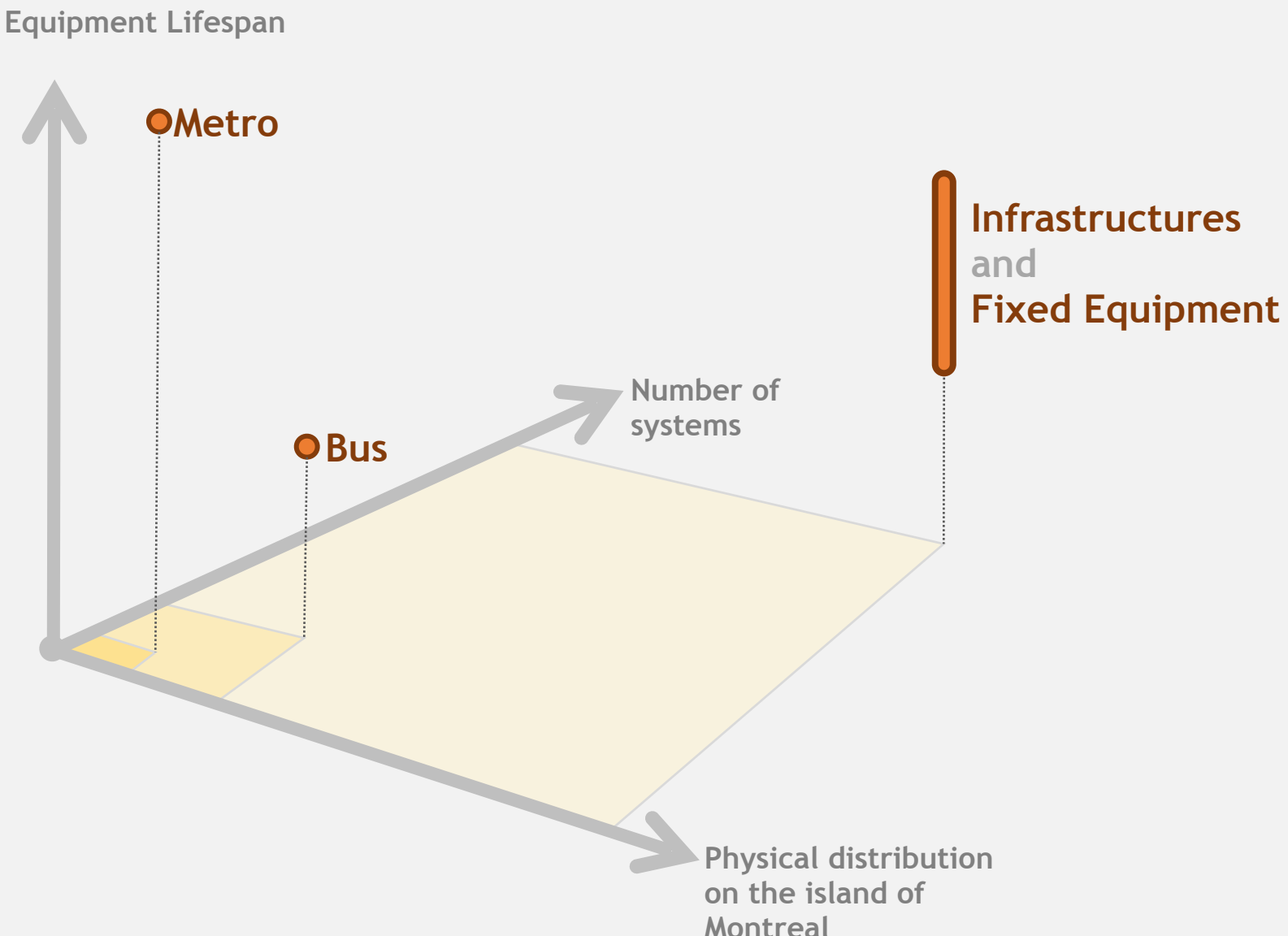
Bus :
- 10 transport centers: bus storage and repair centers
- 1 spare parts repair plant
- 1 mechanic line
- 1 body repair line

Metro :
- 2 repair centers
- 1 spare parts repair plant

50+ warehouses!

References :
https://www.stm.info/fr/presse/communiques/2022/budget-2023-et-pi-2023-2032-de-la-stm----adapter-et-outiller-la-stm-face-aux-defis-actuels-et-futurs

FOUR MAINTENANCE SECTORS WITH THEIR OWN REALITY.

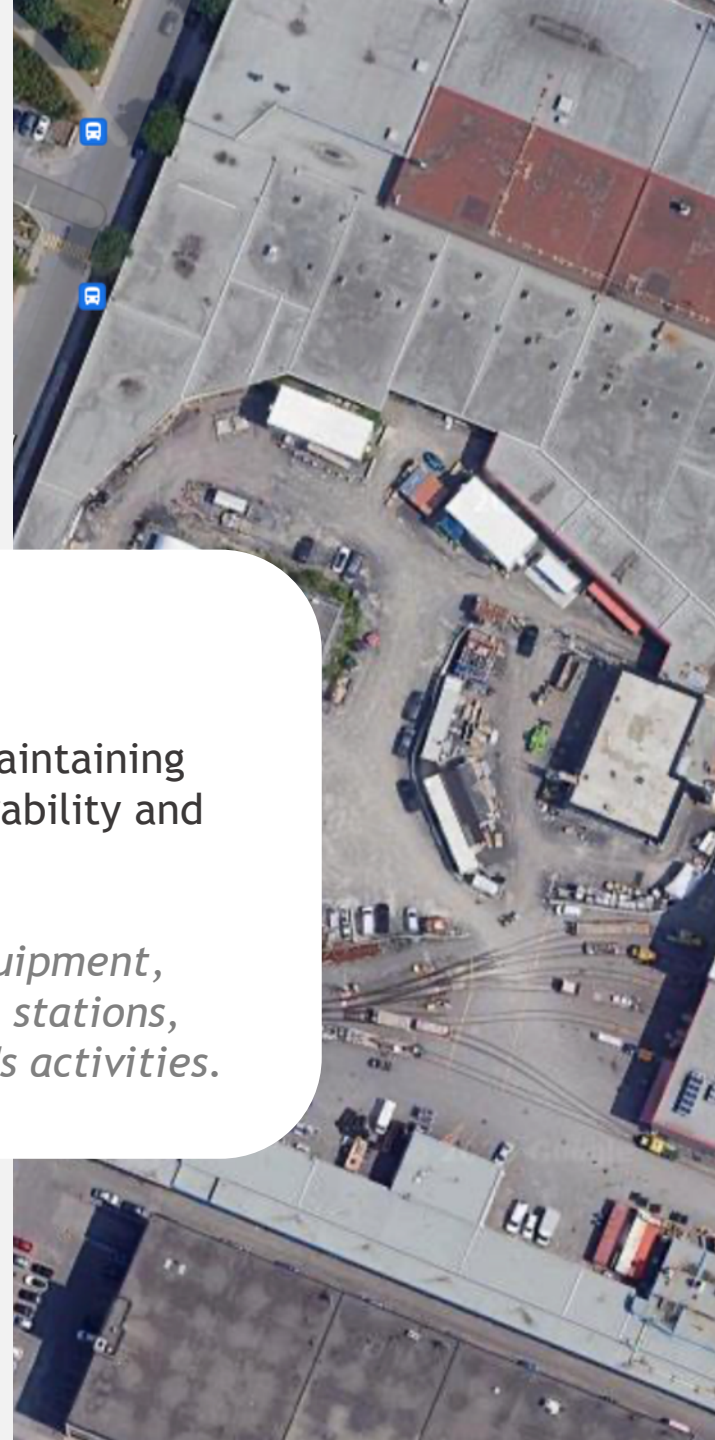


THE CHALLENGE OF MAINTENANCE MANAGEMENT

Maintenance Management

Maintenance Management is the process of managing and maintaining organization’s assets to ensure their proper functioning, durability and availability for operations.

At the STM, assets can include track equipment, station equipment, repair workshop machinery, vehicles, infrastructure such as metro stations, computer systems, and other essential elements for the organization's activities.

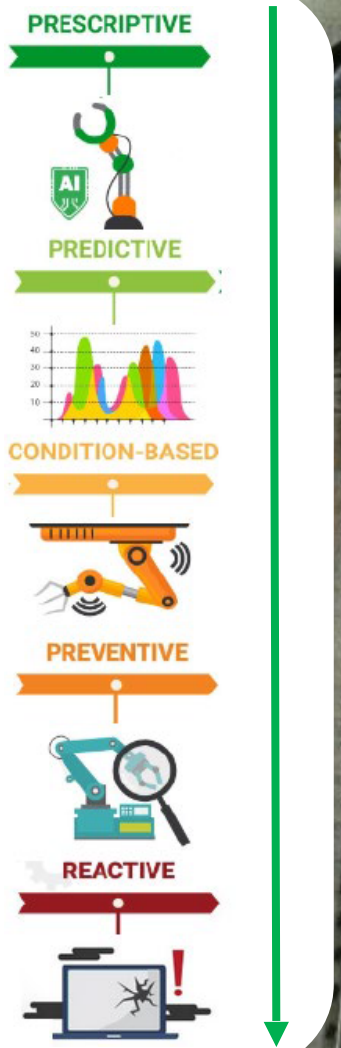


THE CHALLENGE OF MAINTENANCE MANAGEMENT

Maintenance Planning

There are several maintenance strategies. These strategies vary in terms of their reactivity. The more reactive they are, the less the needs for spare parts and skilled labor are predicted.

An organization's ability to predict its maintenance needs will enable developing more cost-effective resource acquisition strategies and overcome daily disruptions to operations, such as delays in the global supply chain, absenteeism, labor shortages, etc.



THE CHALLENGE OF MAINTENANCE MANAGEMENT

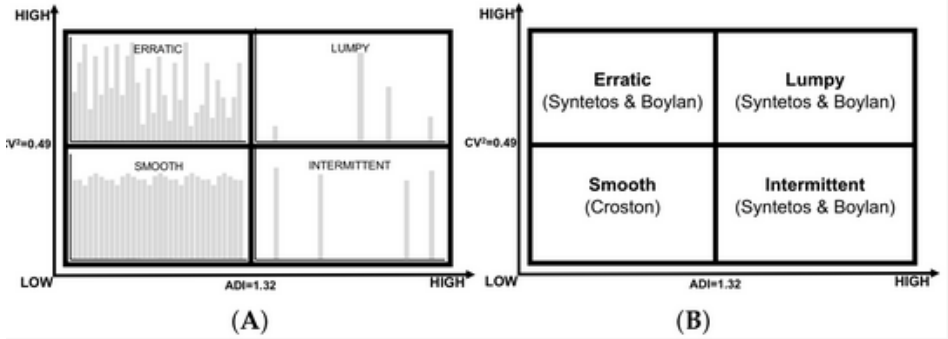
1

Maintenance Planning

Spare parts demand forecast is a very specific area of demand planning, defined with sporadic and lumpy demand profiles.

Unlike a retail store that can remove a product from its product catalog if it doesn't sell well or doesn't generate profit, a maintenance company cannot decide to remove a part from its catalog just because it has low or infrequent demand.

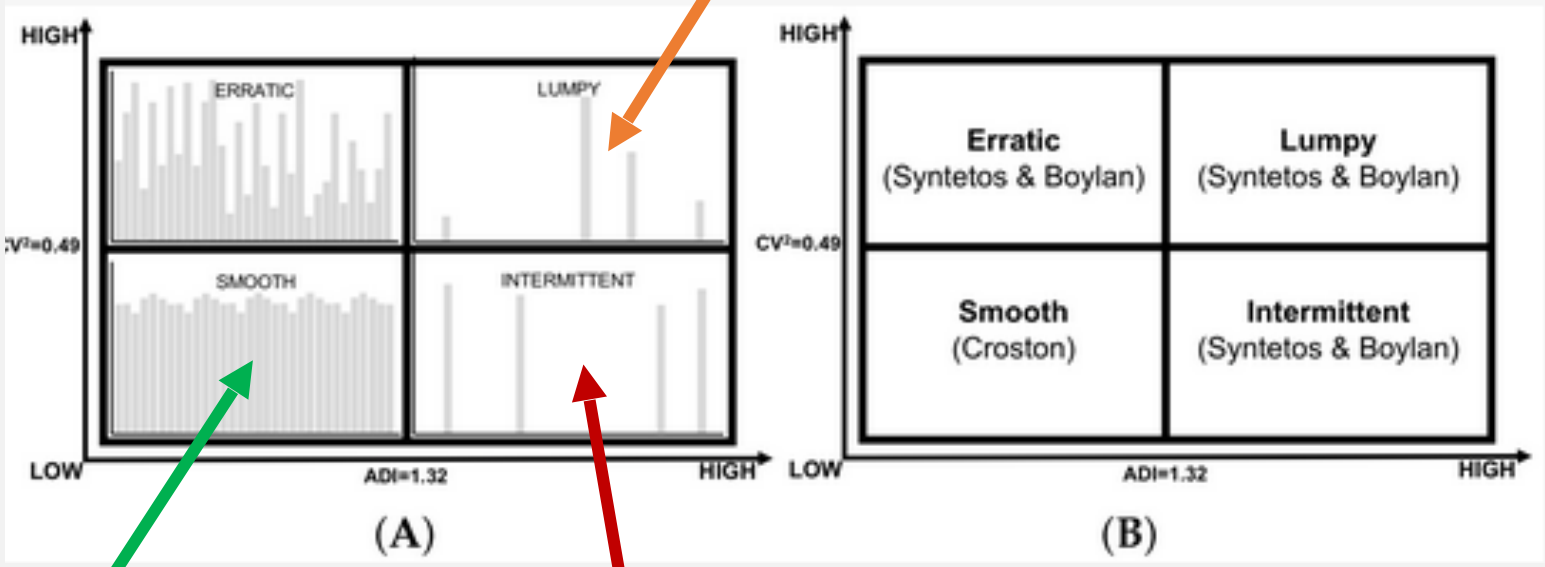
Figure 1. Demand pattern classification. (**A**) depicts different demand patterns, while (**B**) shows the classification proposed by Syntetos et al. [5] based on empirical findings.



THE CHALLENGE OF MAINTENANCE MANAGEMENT

Drive train

Figure 1. Demand pattern classification. (A) depicts different demand patterns, while (B) shows the classification proposed by Syntetos et al. [5] based on empirical findings.



Screws

Light bulbs

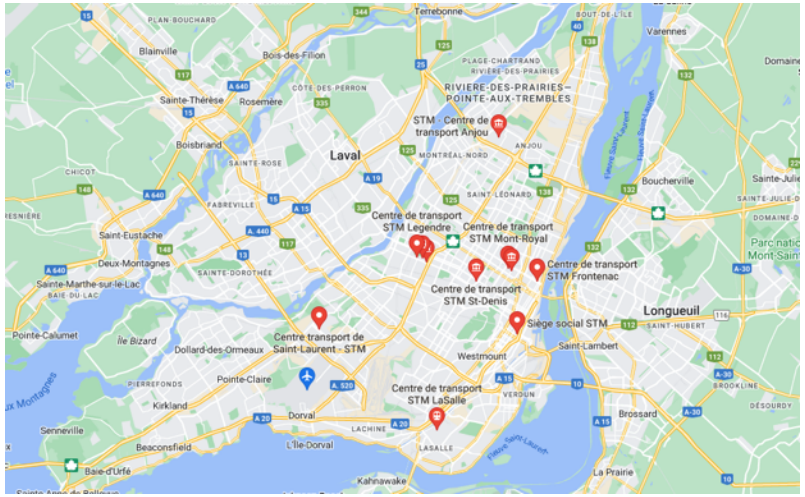
INVENTORY MANAGEMENT : A MAJOR CHALLENGE

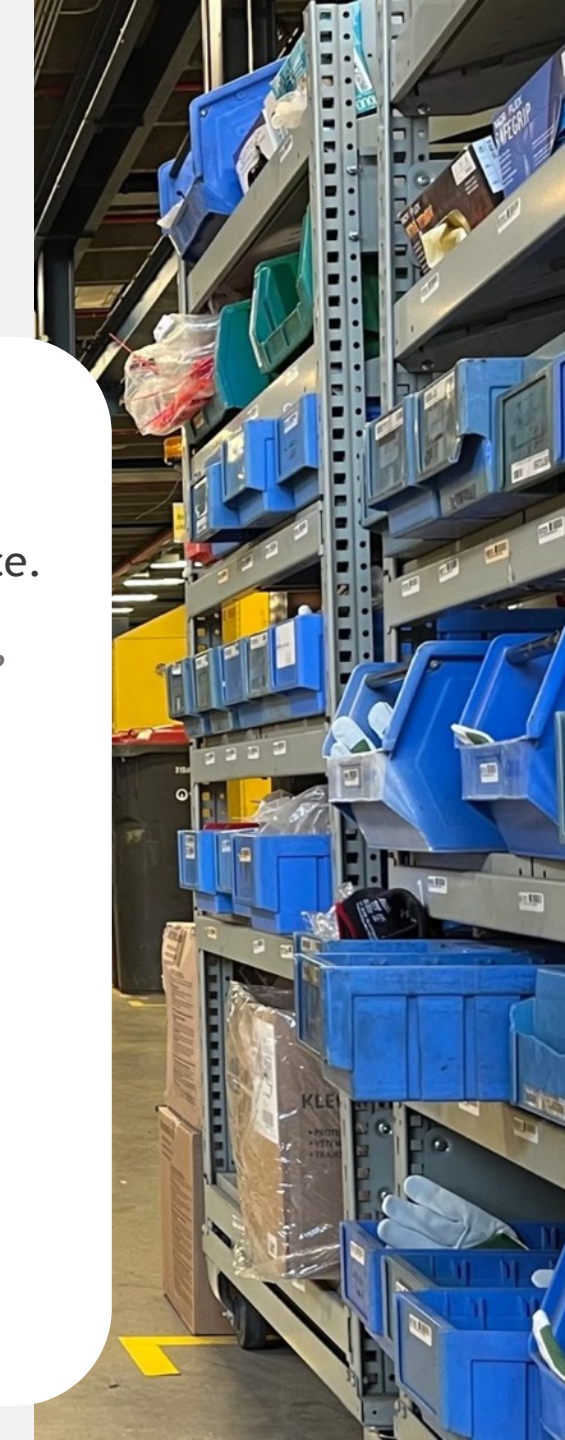
Spare Parts Management

Refers to all activities and processes related to the acquisition, management, storage, and use of spare parts required for asset maintenance.

The challenge is to have the right spare parts in the right place, at the right time, in all repair shops of the organization, while minimizing storage costs.

2





INVENTORY MANAGEMENT : A MAJOR CHALLENGE

2

Spare Parts Management

STM's parts catalog is made up of 84,000 different items, each with its own storage and supply parameters in our **Entreprise Ressource Planning** (ERP) software, depending on where it is stored.

Several hundred thousand warehouse items with storage and supply parameters to be kept up to date. 15 people are responsible for updating these parameters within the organization and have them in line with the demand forecasts they made.

INVENTORY MANAGEMENT : A MAJOR CHALLENGE

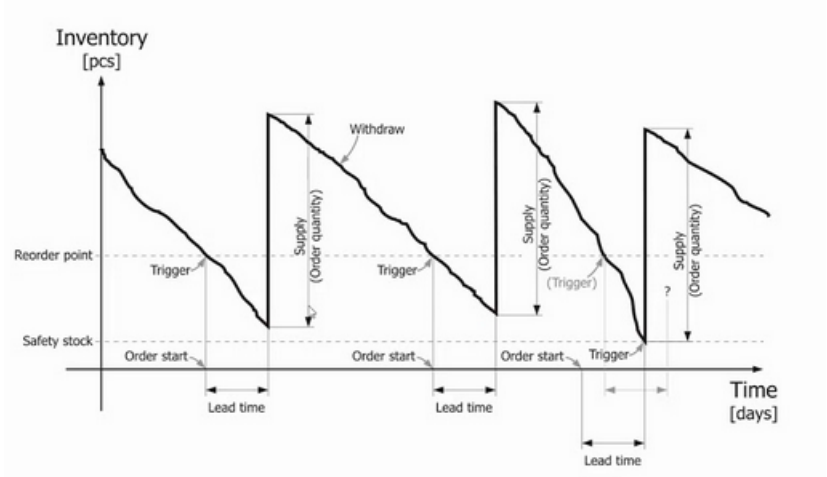
2

Spare Parts Management

Today, the STM uses an inventory management strategy based on ishment thresholds. There are very little forecasting in the system. sts are used to update reorder points.

So with 15 people responsible for updating these storage and supply meters in the organization,

Order of magnitude: 10^5 / 10^1 =10^4 reorder points are maintained per planner.

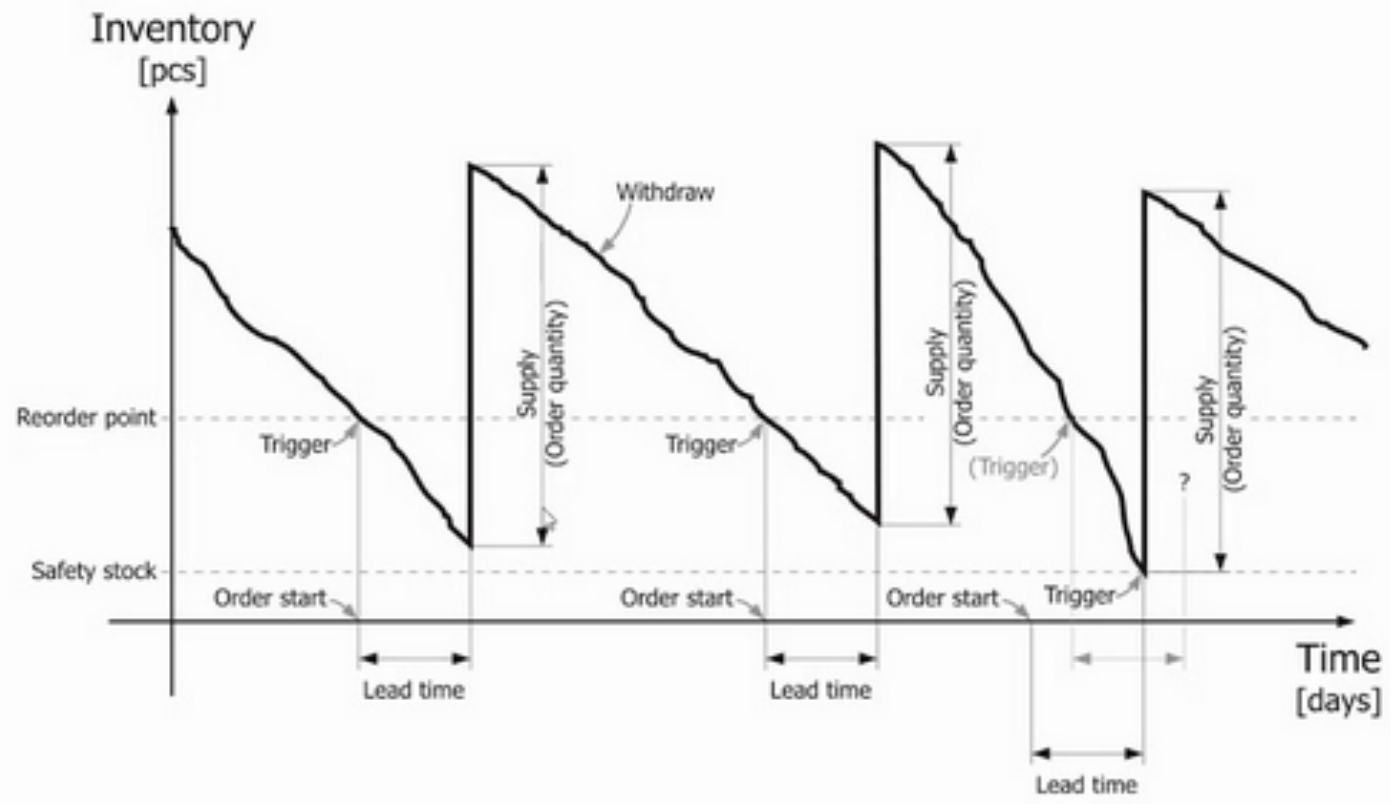


INVENTORY MANAGEMENT : A MAJOR CHALLENGE

Issues with this strategy :

- Variation in lead times on global supply chain,
- Lot of variation in our demand,
- Thousands of parameters maintained by hand,

The result is whether stockouts or overstocking these items.



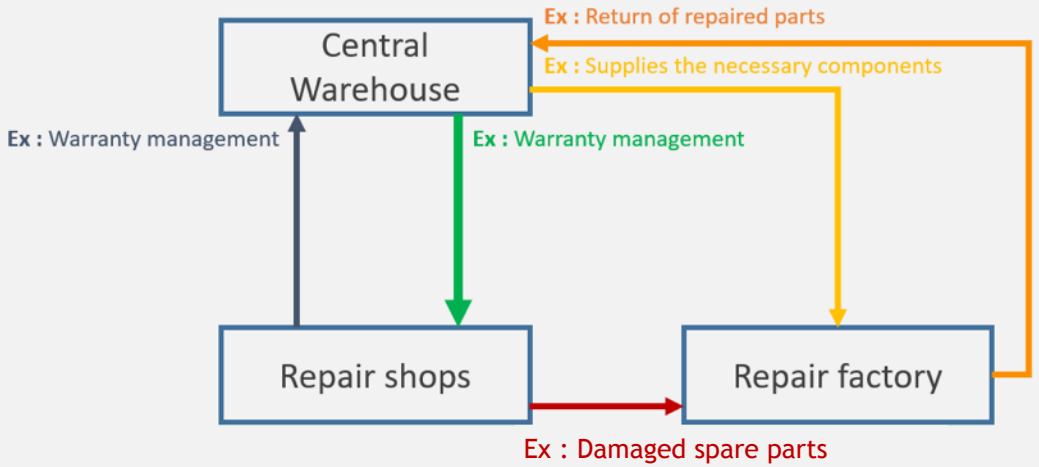
THE CHALLENGE OF MAINTENANCE PLANNING

3

Logistics Network

The STM carries out its merchandise distribution in a multi-tier supply ain. A central warehouse supplies nearby warehouses, which are closer to the erations and have limited storage space.

In-house production plants enable the manufacturing, refurbishment, or repair of some of the spare parts required for the maintenance of our assets.



RESEARCH PROBLEM

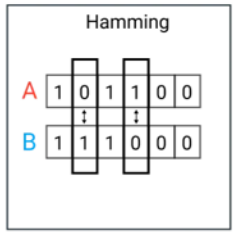
Problem 1

Spare part classification based on « demand profile »

Identifying these groups will allow us to manage bundles of items rather than individual items. By identifying the most suitable storage and procurement strategy for each of the "bundles of items," we believe we can address these labor issues.

Within groups of parts with similar demands, we should apply similar storage and procur strategies. The goal is to reduce the number of SKUs to manage and gain control over ou catalog.

3. Hamming Distance

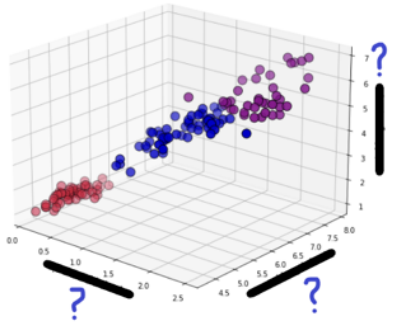


Hamming distance. Image by the author.

Hamming distance is the number of values that are different between two vectors. It is typically used to compare two binary strings of equal length. It can also be used for strings to compare how similar they are to each other by calculating the number of characters that are different from each other.

***Activity 1**: Identify a "distance metric" to assess how close two spare parts need to be to be considered as part of the same demand profile.*

***Activité 2** : Apply clustering methods to form groups with similar demand profiles. How many groups should we form?*



RESEARCH PROBLEM

Problem 2

Identify the most efficient forecasting method for each of the group of items with similar demand profiles.

Conventional statistical forecasting models work very well for parts with relatively stable consumption patterns. For parts with more sporadic and lumpy demand profiles, th models are less effective and shouldn't be used.

Researchers such as Croston, Boylan and Syntetos have extensively studied these statistical models. The STM would like to evaluate their performance on its parts c

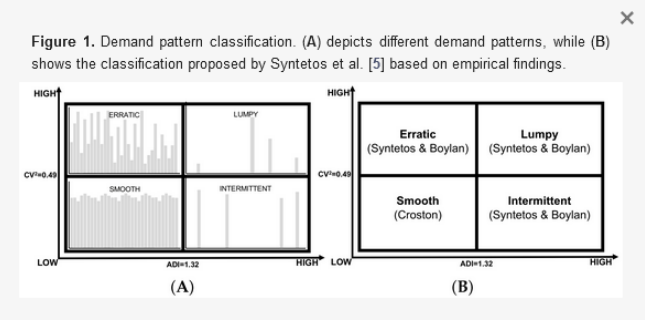


Figure 1. Demand pattern classification. (A) depicts different demand patterns, while (B) shows the classification proposed by Syntetos et al. [5] based on empirical findings.

***Activity 1**: Identify which forecasting method performs best within each of the previously identified groups.*

***Activity 2**: Identify a composite/adaptive forecasting method that would be able to perform within each of these groups.*

DATA AVAILABILITY

Study Data

Spare part consumptions since October 2019.
Planned / unplanned qualification

Temporal evolution of asset fleets (Metro and Bus only)

Item catalogs and their current storage and supply parameters

List of spare parts requests (needs)

Three Databases :

- ***Metro** : Stable Fleet. Doesn't cover the entire lifespan of the assets.*
- ***Bus** : Evolving fleet. Many parts added to the catalog every year.*
- ***Infrastructures** et **Équipements Fixes** : Extremely variable assets. Constantly integrating new equipment . Generally unable to accurately allocate consumption to assets. Too many different assets.*