Advanced Analytics &
Business Consultancy

SONAE ARAUCO
Taking wood further

Optimizing Joint Portfolio Planning And Production Strategy For A Wood-based Panels Producer

Gurobi Live Barcelona - The Decision Intelligence Summit

October 2023

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Sonae Arauco’s challenge characterization

Methodology

Simulation-optimization module

Results

Project management and change management

LTP is a boutique analytical-driven management consultancy

Who we are

A **proven data-driven approach** enables LTP to address the complex challenges faced by its clients.

LTP combines **advanced analytics with business expertise** to deliver significant and sustainable impact in **bottom line profitability**.

80+ consultants

250+ projects

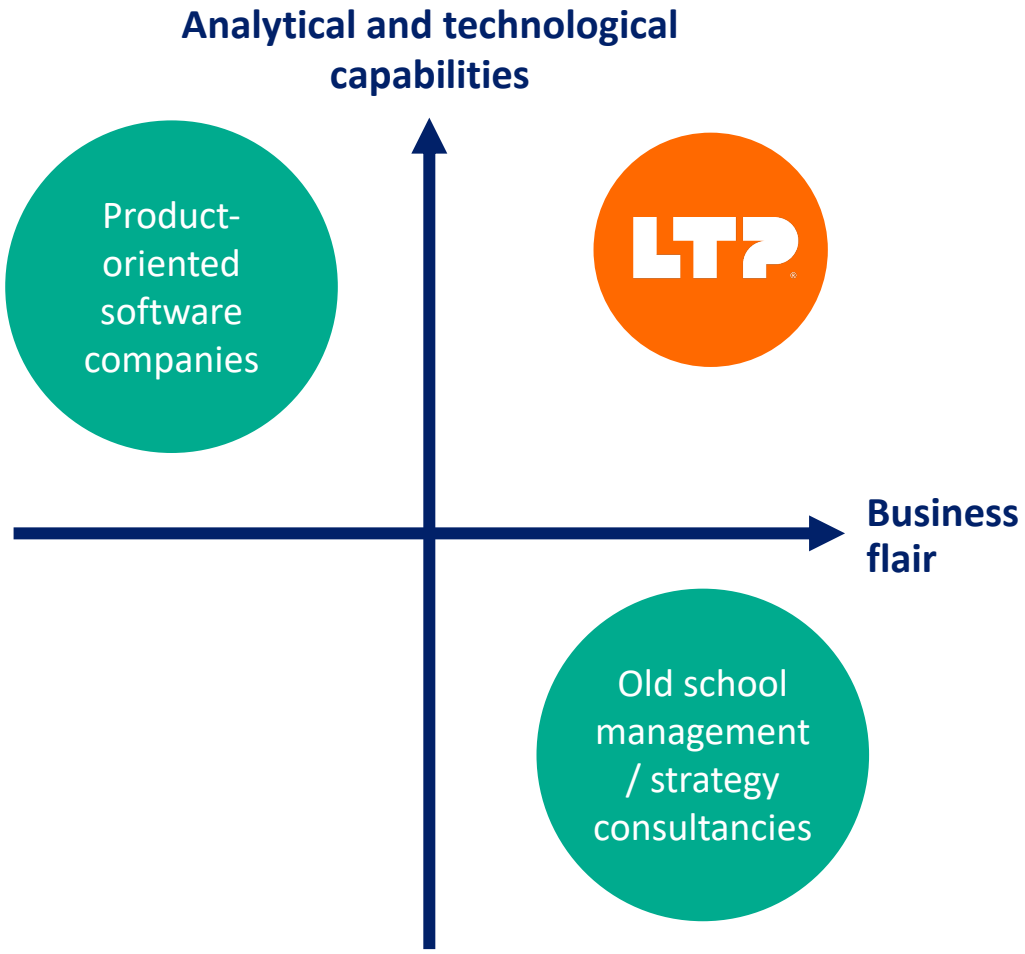
20+ countries

>25% annual growth[1]

1 Annual growth rates always above 25% in the past 5 years

It is the blend of analytical capabilities and business flair that truly sets LTP apart from other providers

What makes us different



Versatile analytical power

50+ consultants experienced in data science, optimization, simulation and BI

Rich business expertise

Vast work across sectors, by a team with diverse professional backgrounds

Solid research background

Academy spin-off with strong R&D skills (+100 case studies and papers papers on renowned entities)

MIT Sloan Management Review · Harvard Business School · European Journal of Operational Research · IESE

LTP has a wealth of experience in facing crucial business challenges with the same data-driven mindset

Our scope of action

NOT EXHAUSTIVE

Marketing & Sales

Growth

Market & demand
How to anticipate sales trends?

Pricing & promotions
When and how to change prices?

Targeted marketing & customer insights
What is the next best offer for each client?

Footprint & assortment & profitability
Where to open the next store? Which products to sell?

Supply Chain & Operations

Efficiency

Network design
What is the ideal supply chain configuration?

Production strategy
When and where to produce each lot (MTS vs. MTO)?

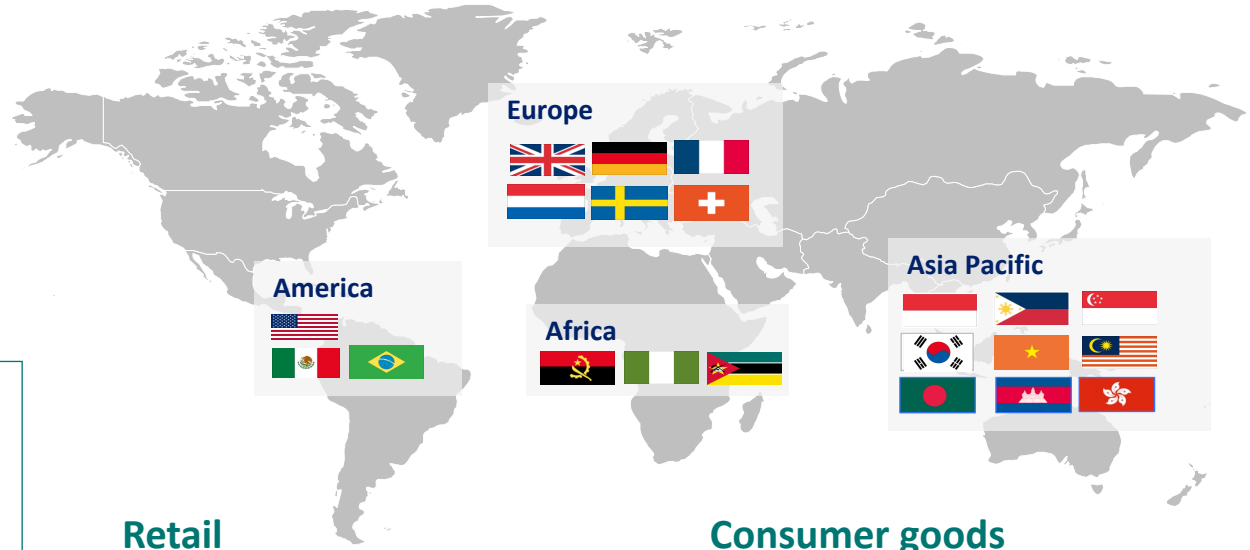
Supply chain & inventory
How to coordinate inventory with product flows?

Capacity & workforce
How to balance and optimize resource allocation?

Reputable companies across several sectors and geographies trust LTP as a key partner for business analytics

Who we partner with

NON-EXHAUSTIVE



Services

universo
ctt
NOS
BPI
cuf
MDS GROUP

Retail

SPAR
FARFETCH
MC Sonae
worten
SIXT
ibersol grupo
fnac

Consumer goods

JTI
Unilever
P&G
Carlsberg
H.B. Fuller
GALLO Worldwide
sovena

Manufacturing

galp
prio
edp
THE NAVIGATOR COMPANY
TMG GROUP
frulact
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who we are

One of the world’s most relevant players in the wood-based solutions industry.

TURNOVER **1,143M€**

EMPLOYEES **~2600** NATIONALITIES **37**

PRODUCTION CAPACITY **3,9M M³**

SALES IN **68** COUNTRIES

Key Figures (2022)

Different wood products are produced and sold by the panels manufacturer

Portfolio

Particle Board

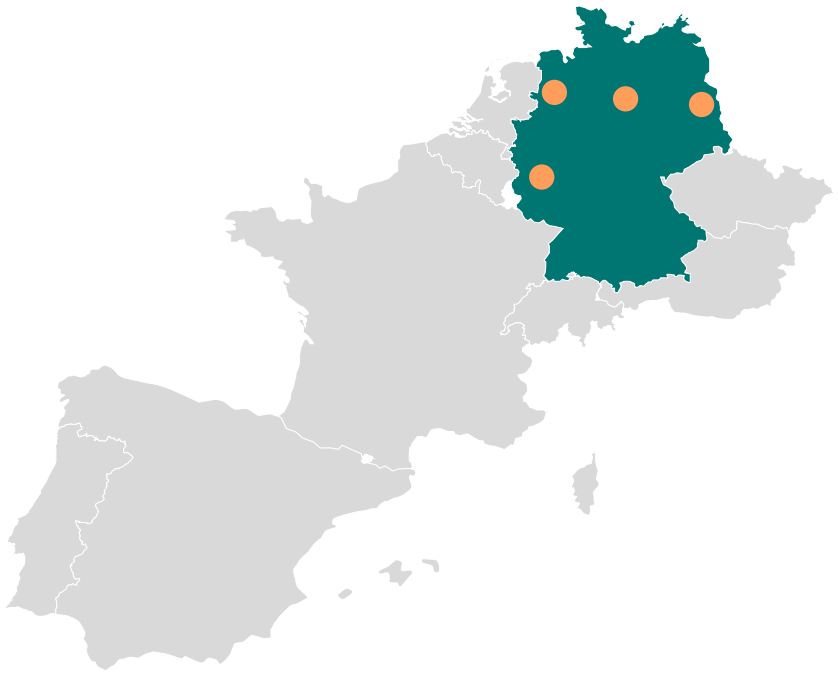
Melamine Particle Board

(Melamine) MDF

OSB

The scope is the German industrial context, considering all relevant facilities

Scope



This project focuses on four **German facilities**

The production of **PB, MFC, MF, MDF, and OSB are** modelled, as well as the **IMP** (impregnated paper) constraints

Additionally, besides the four main facilities, all **other relevant infrastructures** are considered (e.g., central warehouse)

PB - Particleboard | MF – Melamine | MDF – Medium Density Fibreboard | MP – impregnated Paper | OSB – Oriented Strand Board

The current MTO-oriented production strategy leads to a challenging pursuit for an excellence service level

Initial status

KPI's	Main Insights
A **Production Output (m^3)**	• Most **production** concentrated on **Make-to-Order (MTO) and Finish-to-Order (FTO) products** (82%) • Other B2B companies **satisfy** most **demand from Make-to-Stock (MTS)** products
B **Stock Level (m^3)**	• **Most space** (62%) is occupied by **MTO and FTO products** • **Large proportion** of stock (17%) composed by products **without orders during 2021**
C **Service Level (days)**	• **MTS products** have a **more agile** response, but the **SLA compliance** is **low** (62%) • **Most SKUs** (70%) are **ordered** only for **one customer**, and **half** of these are **ordered** only **once** per year
D **Availability losses (h)**	• **Change-overs** account for **29%** of **availability downtime** • **Full change-over** had the **most impact** on downtime

Different pain points emerged during the initial diagnosis

Pain points summary

Production strategy mix

Improve service level by redefining the current **MTS/MTO/FTO strategy**

Stock occupation

Space is one of the main constraints in planning, which requires higher efficiency in **stock planning**

Low support from analytical tools

Static decisions, supported by **managers expertise**, and with reduced support from advanced analytical models

Lack of KPIs

Lack of KPI monitoring throughout the **teams** (both from demand planning and operations teams)

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Today’s session

Today’s session

Deciding **how to address the market in terms of offering while ensuring production efficiency is paramount for success**

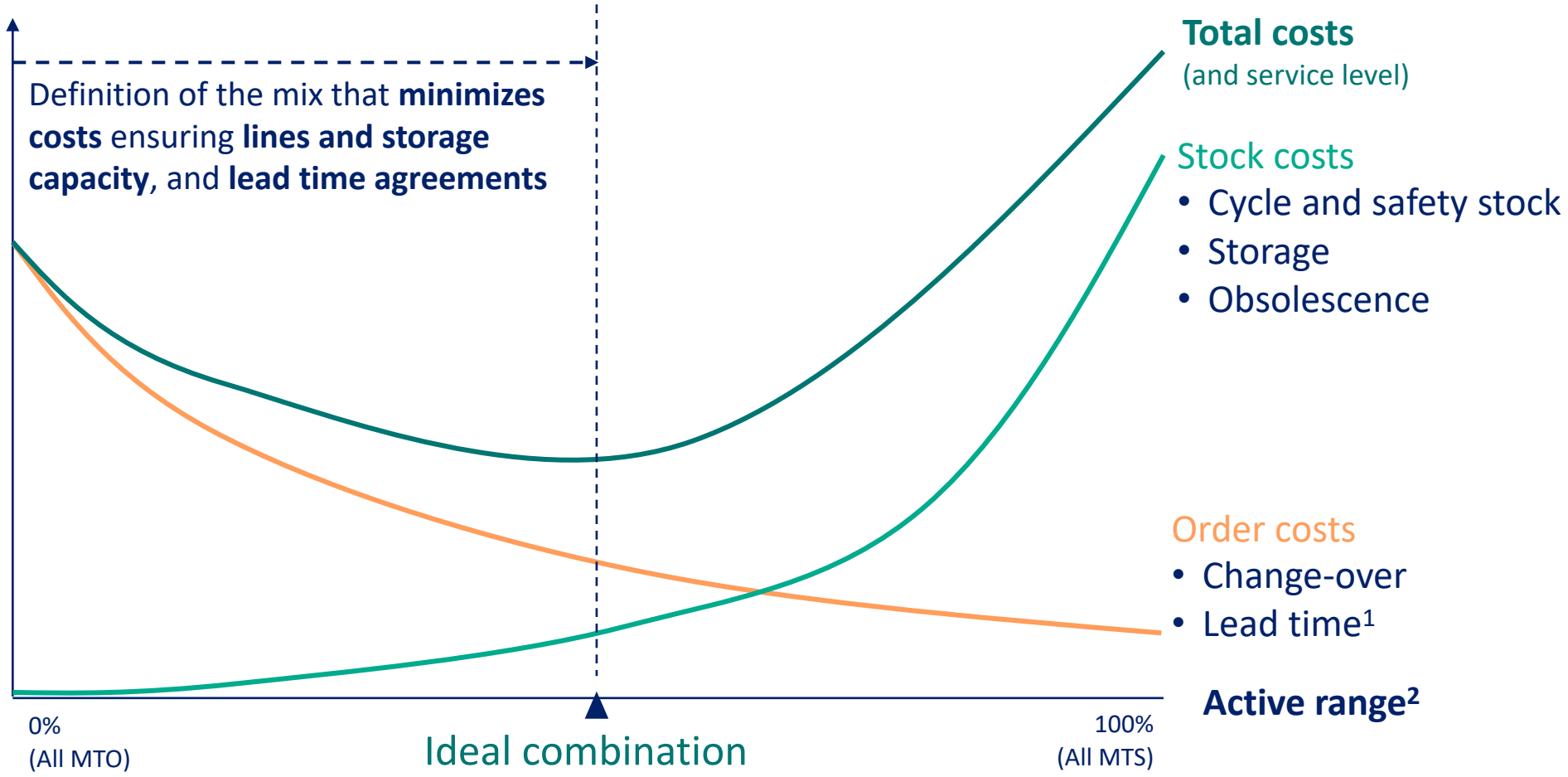
In the case of the **wood-based panels’ producer motivating this talk**, they strived while revising their **products catalog**, given the difficulty of **anticipating the capability to fulfill demand, and the lead times that should be agreed** upon with the customers

To tackle this issue, a **simulation-optimization model was developed** that provides the Marketing and Supply Chain teams with the capability of **optimizing the production strategy for each product** (i.e., make-to-stock, make-to-order, finish-to-order) and **related lot sizes and expected stock levels**, while conducting **what-if analyses regarding the portfolio to be offered**, and the **promised lead time** for each product

In this talk, we will present the **process of building this model**, the **obtained results**, and the difficulties that arise with the involvement of multiple stakeholders and the **process designed to smoothen the adoption**

Given the initial challenges, a production strategy optimization methodology was proposed

Production strategy rationale (1/2)



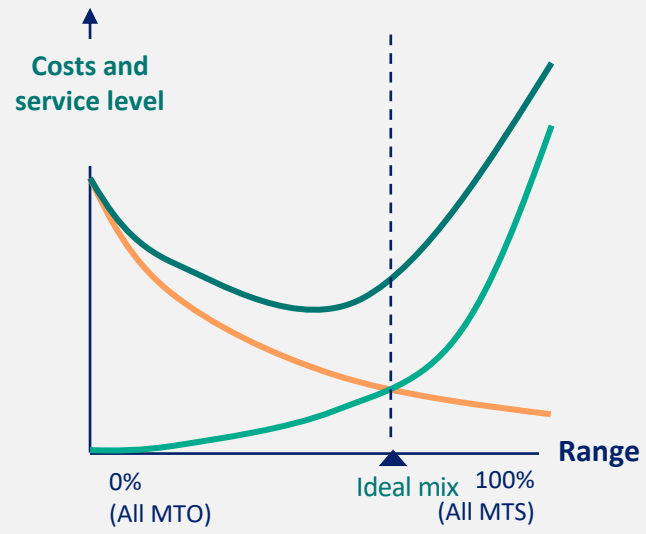
1 Cost of not meeting agreed SLA with customer | 2 At SKU level (board type, thickness, width, paper, finishing)

The methodology should be applied throughout the entire production process to maximize its impact

Production strategy rationale (2/2)

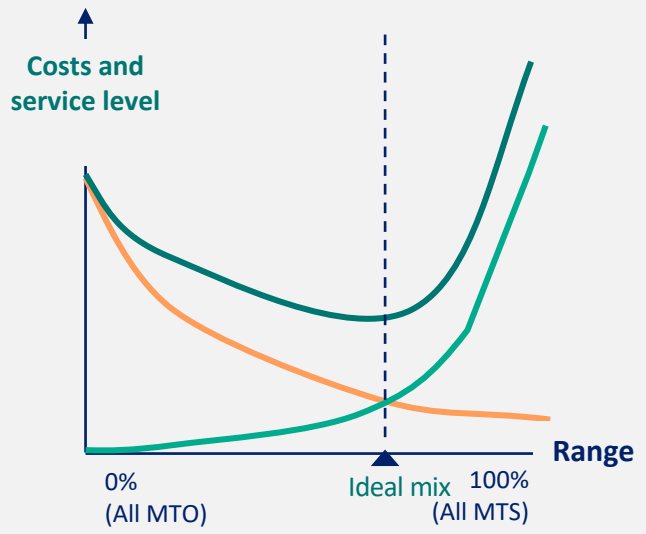
ILLUSTRATIVE

Paper



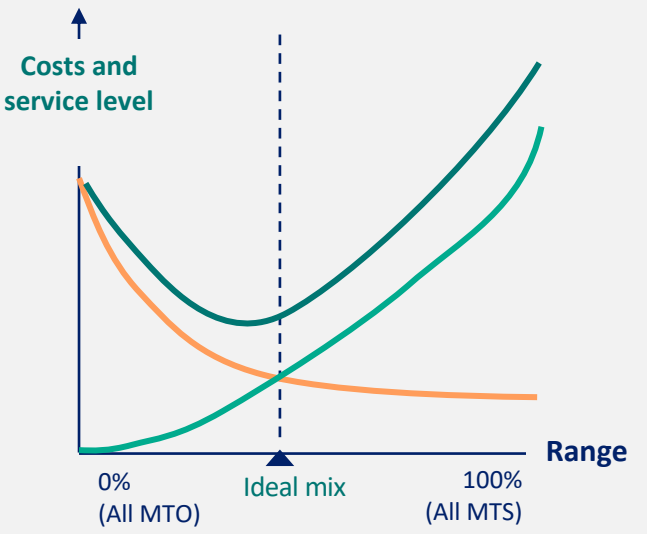
Product detail: Paper

Raw board



Product detail: Board type, thickness

Finished product



Product detail: Board type, thickness, paper, finishing

The combination of the **best strategy** for **paper, board**, and **finished product** results in an **optimal MTS/MTO/FTO classification** for each product (board type, thickness, paper, finishing)

An mixed integer linear programming approach was employed to optimize operational and commercial indicators

Optimization approach

Optimize operational & commercial KPIs

Considering the active portfolio of products, production lines and storage facilities

- Setup time and number
- Stock levels
- Line utilization
- Lot sizing
- Storage utilization
- Lead time and OTIF

… having in consideration relevant constraints..

Production

- Consider **stabilization time** between operations
- Consume capacity with **change-overs** and **production**
- **Product and block frequencies** must be aligned

Storage

- Comply with **allocation rules**
- Consider **capacity and bins limitations**
- **Validity should not be surpassed**

Commercial

- Fulfil **historical lead time and target OTIF**

…by defining (decision variables)

The optimal **production frequency by block and product**

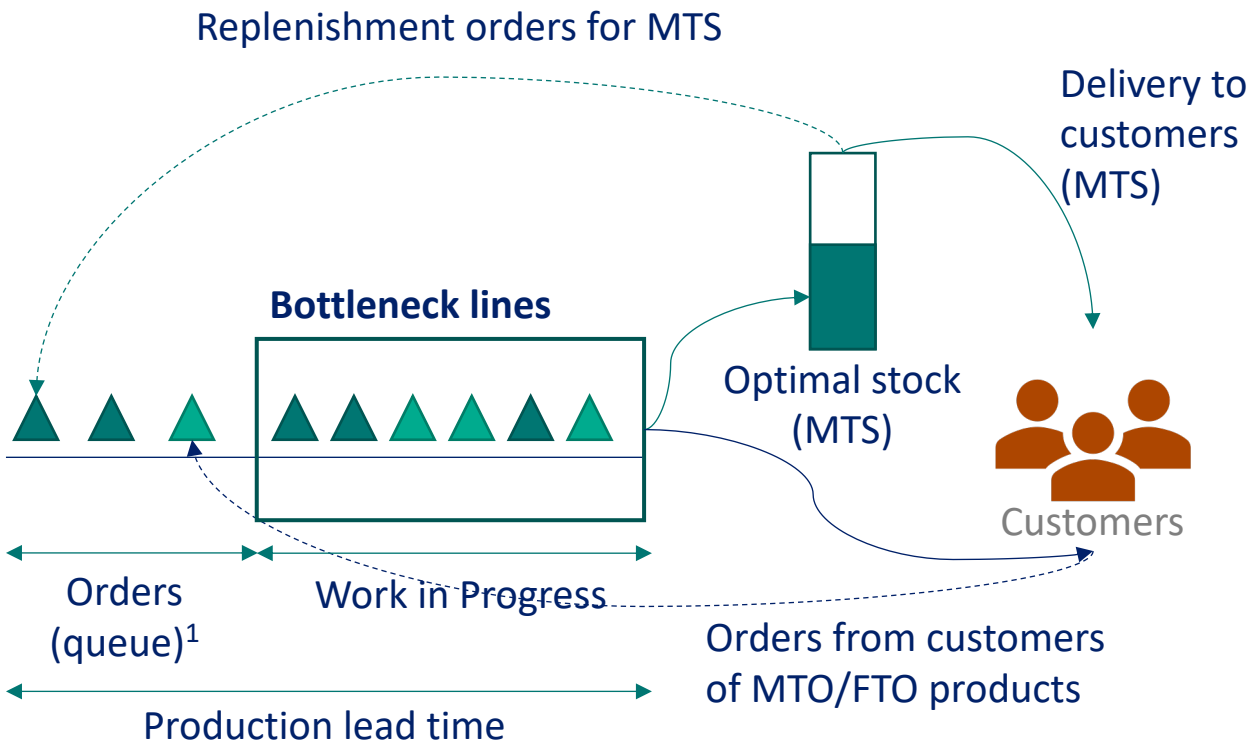
The **production strategy** (MTS/MTO/FTO) by product

The expected **cycle stock and safety stock** at the product level

The **commercial lead time** that can be proposed to the market

The chosen production strategy mix impacts the resulting occupation of the bottleneck lines

Queue dimensioning in bottlenecks



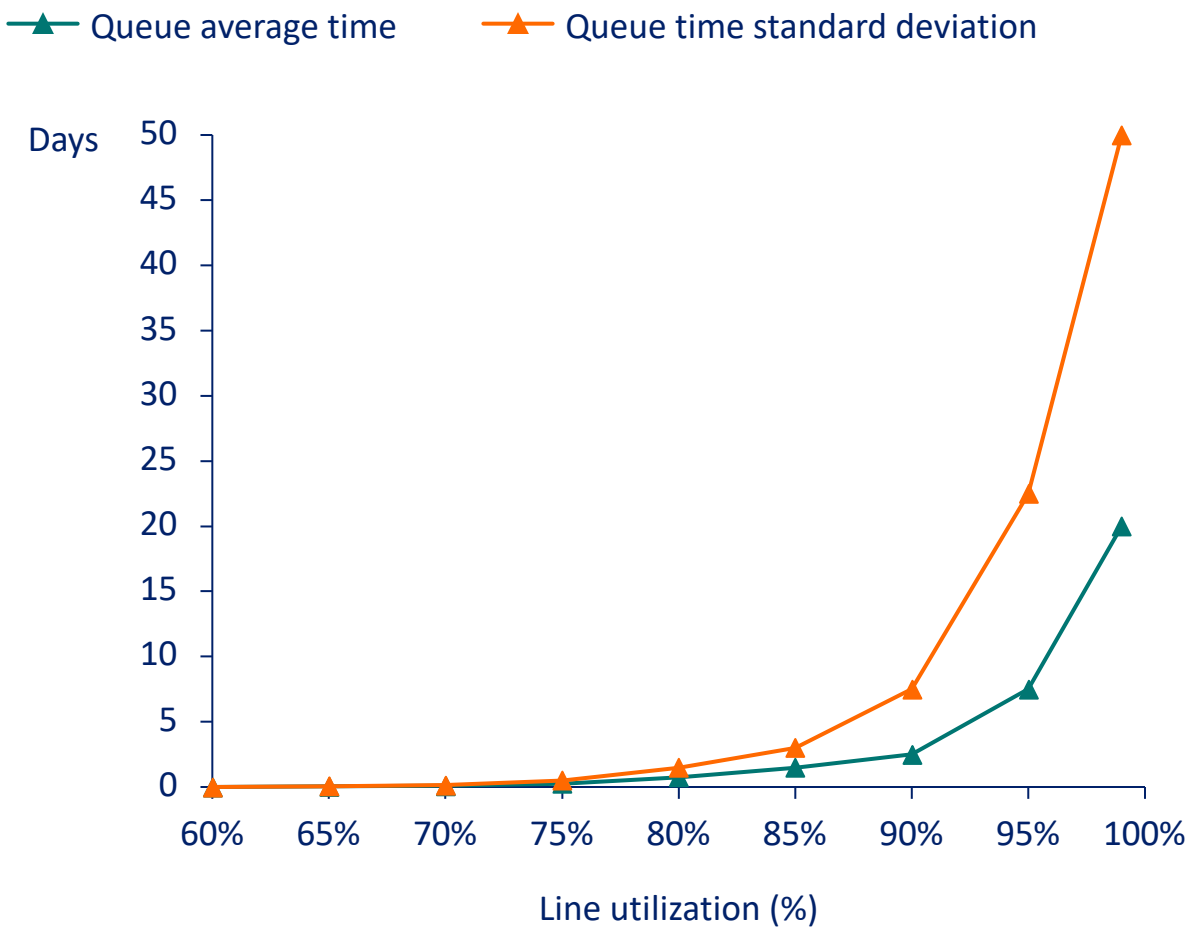
- Depending on the **production strategy**, orders can be fulfilled either by **existing stock (MTS)** or by placing a **new production order (MTO/FTO)**
- For bottleneck lines, a **larger number of orders** would result in **increased queues**, with impact in the production lead time
- An M/G/1 system is modelled, assuming a Poisson arrival process[1]

1 As proposed by Rajagopalan, S. (2002). Make to order or make to stock: model and application. *Management Science*, *48*(2), 241-256.

Different lines utilization scenarios were simulated to overcome nonlinearity issues in the model

Utilization-queue size scenarios generation

ILLUSTRATIVE



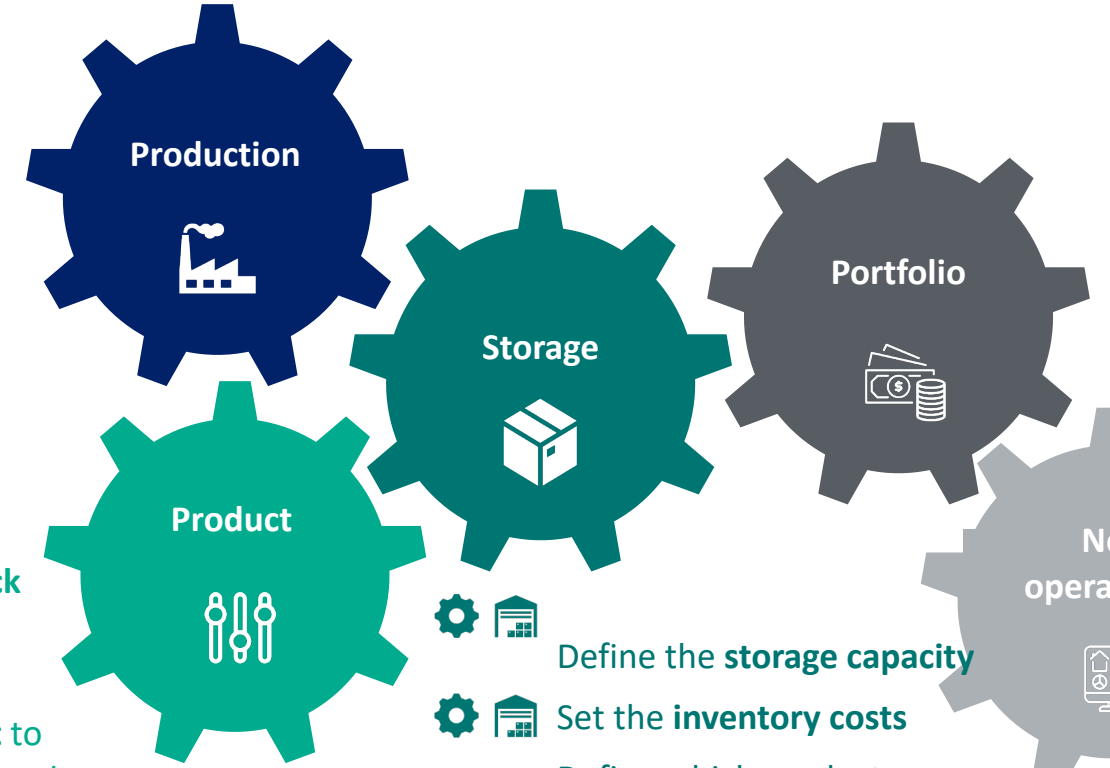
- For each **level of line utilization**, a **different queue time** might be expected, with impact in the **lead time** and **stock levels**
- Scenarios are discretized and the **optimization model chooses the utilization-queue time** that optimizes the intended goal
- A set of **binary variables** is used the accommodate the **possibilities**
- The **portfolio mix** can be regarded as a **'second-level' decision** tackled by the model

Different parameters are managed by Supply Chain and Marketing teams, supporting what-if scenario generation

What-if settings

Responsible for update: Automatic | Supply chain | Marketing

- Update setup, processing and stabilization **time**
- Update the product and setup **costs**
- Set the lines' **capacity and downtimes**
- Set a **target service level** (OTIF)



- Manage **new products** by setting mirror products or creating dummy products
- Pre-define **stock program**[1] products and set **commercial lead times**

- Set the maximum **stock coverage** by product (validity)
- **Fine tune the forecast** to test different scenarios, at product and region level

- Define the **storage capacity**
- Set the **inventory costs**
- Define which products might be **stored at each plant**

- Set **administrative and transport lead time**
- Define the **minimum number of customers**[2] and maximum **share of demand**[2] to consider a product as admissible to MTS[3]

1 Production strategy is a model output, but user may force given products to be MTS/MTO/FTO | 2 Only applied to products without stock program pre-defined | 3 Optional constraint

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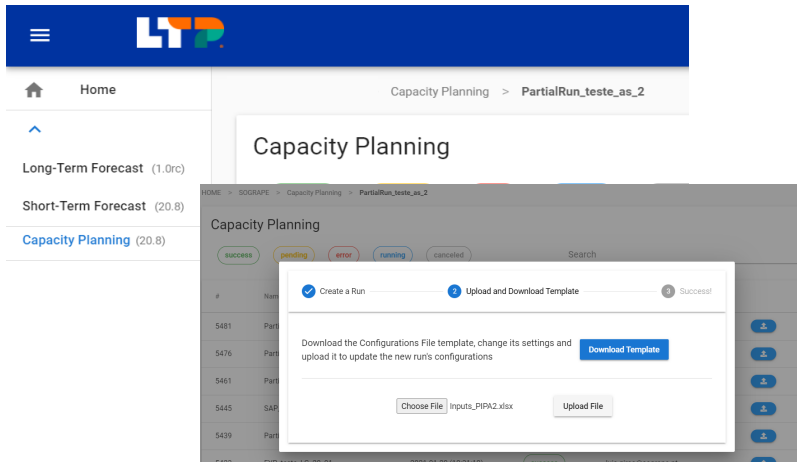
A user-friendly architecture, connected to the company's ERP, was developed to tackle the challenge

Module

A Web interface



B Parameterization file

Transactional Data

Analytical Models

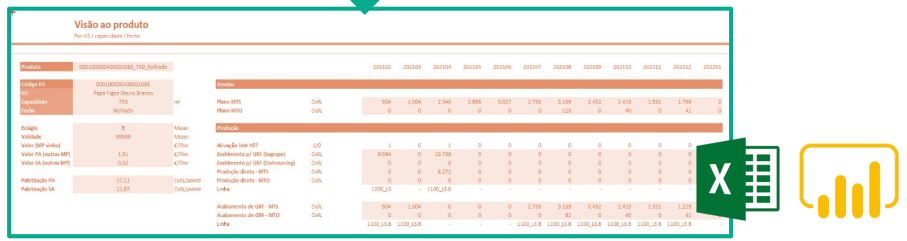
GUROBI OPTIMIZATION

databricks

DB

Microsoft SQL Server

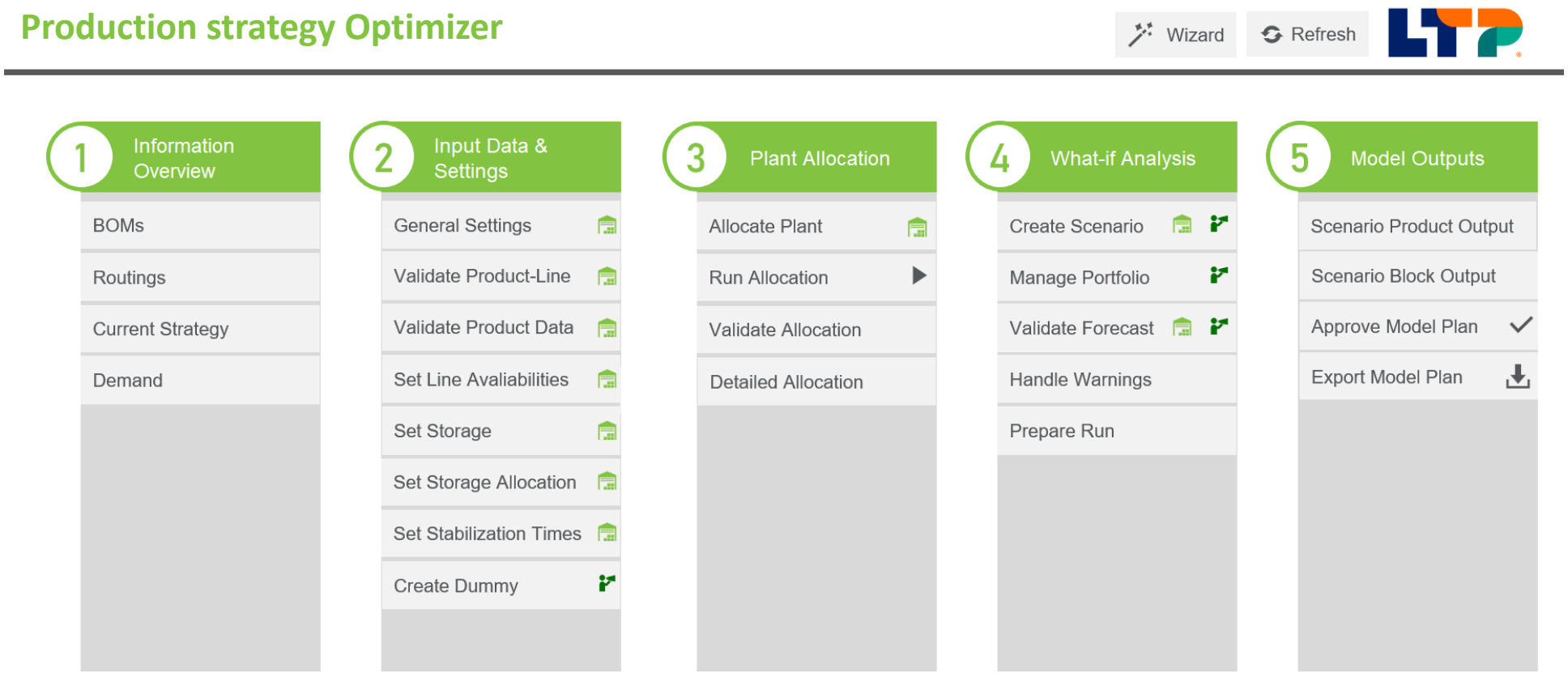
ERP



C Production strategy plan

An optimization model was developed, supported by a user-friendly parameterization interface

B Parameterization module



Each scenario can be thoroughly analyze using the dashboard KPI summary complemented by detail at the material level

C Plan/output analysis

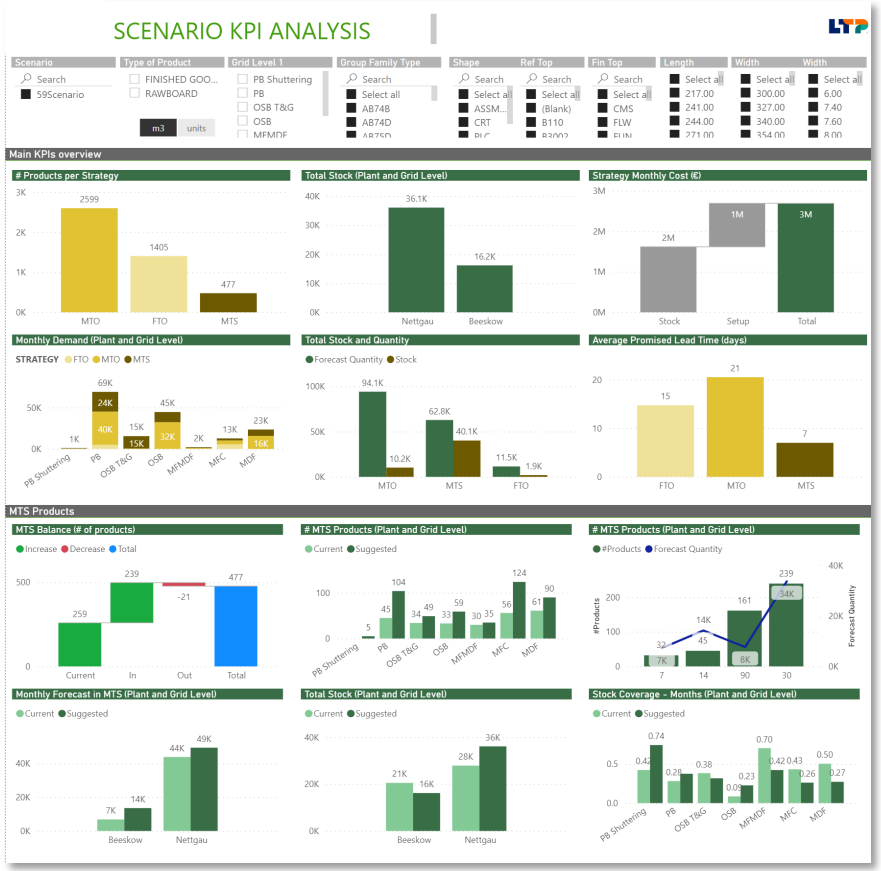
Detailed insights at the material level

Scenario Output

Select Scenario | Save

Material Information					Current Strategy			
GFT	Material	Pack Type	Boards per Pack	Demand	Strategy (MTS/ FTO/MTO)	Production Cycle (days)	Strategy (MTS/ FTO/MTO)	Production Cycle (days)
GFT	MATERIAL	PACK_TYPE	BOARDS_PACK	EMAND_U	C_STRATEGY	RODUCT_CYCLE_D	STRATEGY	FREQUENCY
AB74B	AB74B00913	ND	9999	1672.457	MTO		MTO	7
AB74B	AB74B00924	ND	9999	1192.609	MTO		MTO	7
AB75D	AB75D13926	ND	9999	8.267	MTO		MTO	92
AB79B	AB79B14293	ND	9999	2.157	MTO		MTO	251
AB79B	AB79B14345	ND	9999	18.693	MTS		MTS	90
AB79B	AB79B14347	ND	9999	6.144	MTO		MTO	148
AB79B	AB79B14348	ND	9999	8.919	MTS		MTO	40
AB79B	AB79B14349	ND	9999	54.937	MTS		MTS	30
AB79B	AB79B14350	ND	9999	16.930	MTS		MTO	26
AB79B	AB79B14351	ND	9999	40.596	MTS		MTS	30
AB79B	AB79B14352	ND	9999	0.425	MTO		MTO	276
AB79B	AB79B14354	ND	9999	16.136	MTS		MTO	38
AB79B	AB79B14373	ND	9999	18.296	MTO		MTO	49
AB79B	AB79B14388	ND	9999	3.931	MTO		MTO	252
AB79B	AB79B14512	ND	9999	6.353	MTO		MTO	148
AB79B	AB79B14513	ND	9999	7.199	MTO		MTO	126
AB79B	AB79B14516	ND	9999	10.318	MTO		MTO	63
AB79B	AB79B14587	ND	9999	17.872	MTO		MTO	56
AB79B	AB79B15651	ND	9999	21.964	MTO		MTO	44
AB79B	AB79B15691	ND	9999	11.127	MTO		MTO	84

Main KPIs (dashboard)



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Some what-if scenarios were generated to validate the model's results

What-if scenarios

IMPROVEMENT OVER CURRENT STRATEGY

Comparison between the **model's output** with the **current production strategy** (MTS/MTO/FTO mix)[1], and the **model's output** with an **optimized production strategy**

MAIN CONSIDERATIONS:

S&OE/S&OP 2023 forecast values
Current storage capacity
Current lines capacity
Current service level

STORAGE CAPACITY WHAT-IF

Impacts on the **optimized production strategy** of adding **extra storage capacity** (7k m3)

PORTFOLIO WHAT-IF

Impacts on the **optimized production strategy** of **pre-defining the stock program for some products** (Marketing)[2]

The model works **on top of the Marketing parametrizations**, finding the optimal strategy for the remaining products

1 Supply Chain classification | 2 Additional products might be MTS on top of the Marketing pre-defined list

Some what-if scenarios were generated to validate the model's results

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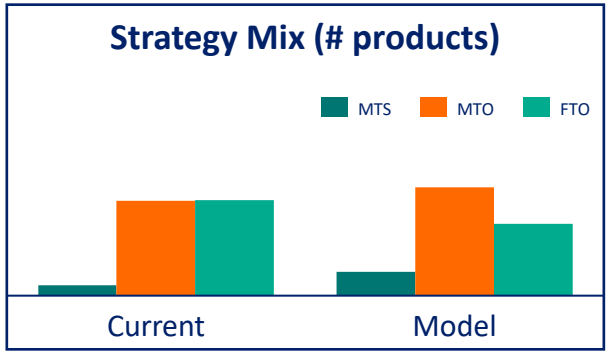
The proposed strategy improves the promised lead time by improving the stock utilization and decreasing change-overs

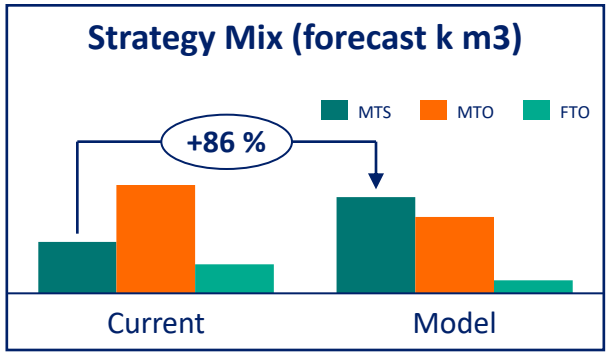
Key metrics

Strategy Mix

Strategy Mix (# products)

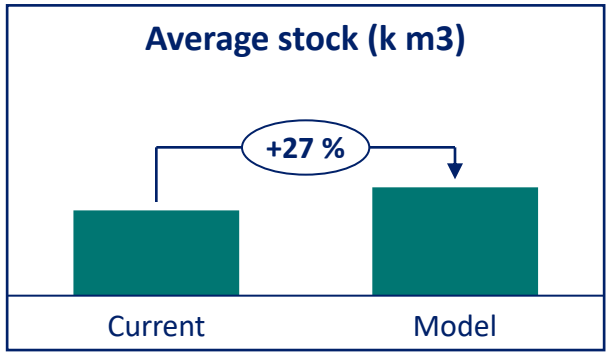


Strategy Mix (forecast k m3)

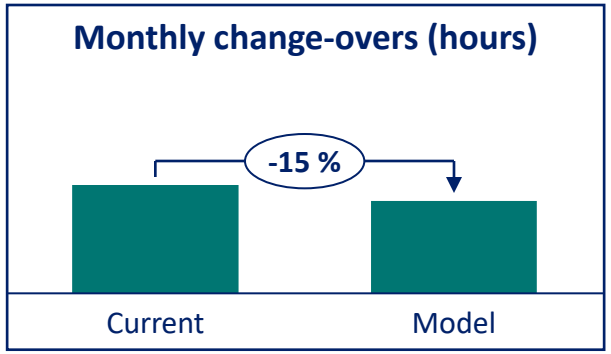


Production and stock impacts

Average stock (k m3)

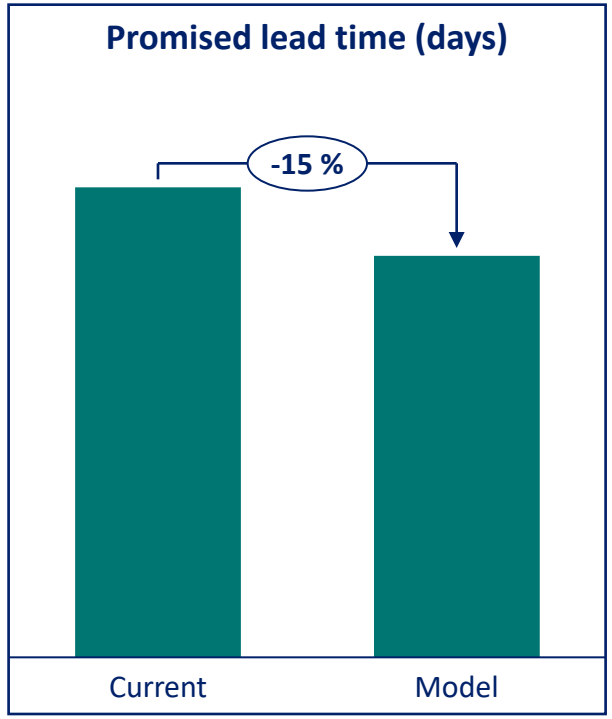


Monthly change-overs (hours)



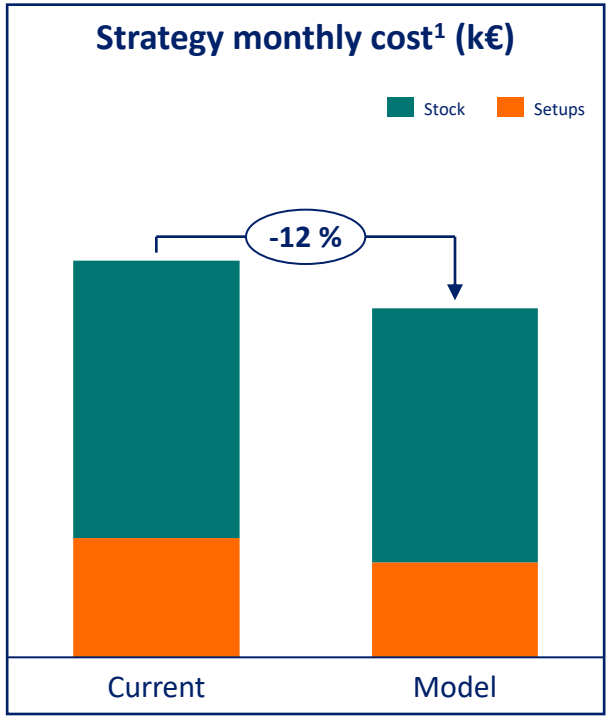
Sales impacts

Promised lead time (days)



Operational costs impacts

Strategy monthly cost[1] (k€)



Increase the average **stock levels**

Decrease the hours in **change-overs**

Improve promised **lead-time** and **reduce costs**

1 Setup and Stock (holding + storage) costs

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The module adoption is being promoted using different change management tactics

Change management tactics

Model and data validation

Several validation sessions were conducted with the **IT team** to validate the data used. Later on, **model recommendation validation sessions** were made with **end-users** (Marketing and Supply Chain teams)

Process design / Governance

Designing an effective **Marketing-Supply Chain governance** to use the model is critical. Defining the frequency of update, and the flow of interactions is of the utmost importance to maximize the model's impact

Knowledge management

Knowledge management and transfer sessions were held with the **IT team** in order to ensure knowledge was acquired by internal team members

Ambassador

The technical support will be ensured by the IT team, but Supply Chain and Marketing team named an **element responsible to ensure the process implementation and new users training**

A combined approach on analytical development, process mapping and change management ensured project's success

Conclusions

- ✓ **Production, supply chain, and marketing processes** were thoroughly mapped to **understand business context** and **unveil improvement opportunities**
- ✓ A **simulation-optimization module** was developed, optimizing **key decisions**: production strategy, production frequencies and lot sizes, stock levels, and lead time proposition
- ✓ A **web-based implementation** allowed the end-users to **connect with the model** and **evaluate different scenarios** in a user-friendly fashion
- ✓ Model results suggest an **increase of the stock levels (MTS)** decreasing the hours spent in change-overs, resulting in **lead-time improvement** and **operational costs reduction**
- ✓ Different **change management tactics** were conducted to foster **model adoption**

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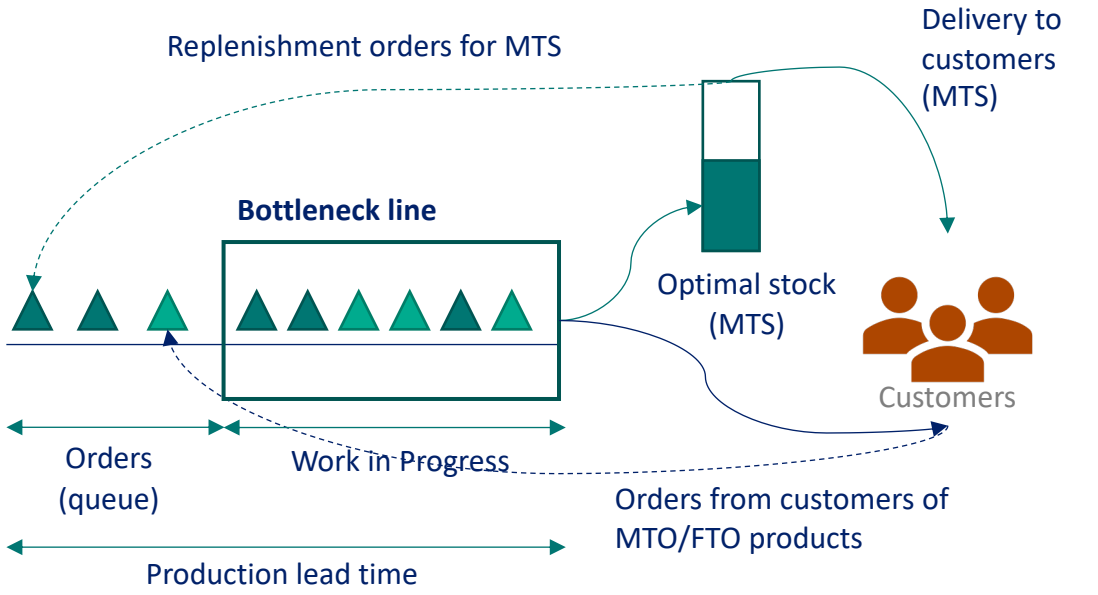
October 2023

The production strategy model considers the whole production system, focusing in the most complex operations

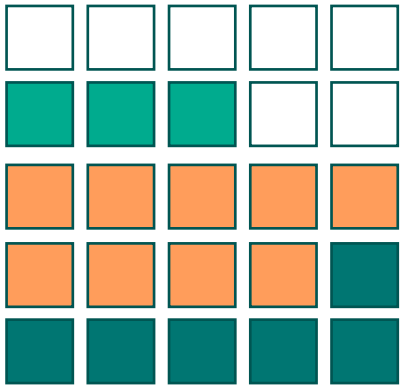
Detailed methodology

Queue line at bottlenecks



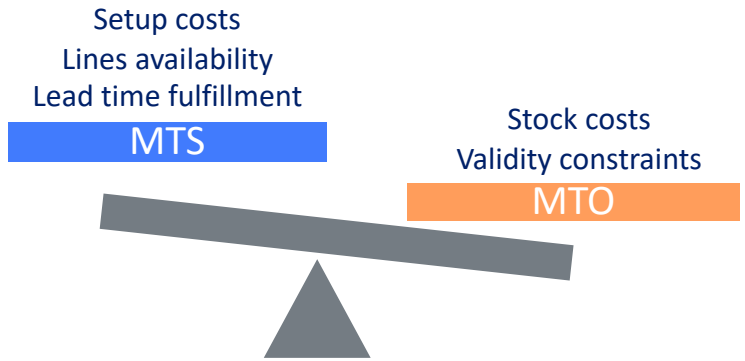
Dynamic and holistic assessment of the impact of different portfolios on production time and lines utilization

Storages utilization



Expected capacity utilization at storages combining MTS, FTO and intermediate goods storage

Cost and indicators analysis



The model is capable of optimizing the overall strategy, weighing the impact that each product's strategy and lot size have on stock levels, lines' availability, and lead time

1 – Example to a product produced in Nettgau (without cut-to-size)

An analytical-based model will generate optimal sales and operations outputs for a given scenario

Detailed methodology (1/2)

Operations-related output
Commercial-related output

Commercial levers

- Active portfolio (and product characteristics)
- Intended commercial lead time for each product
- Sales expectation (volume and no. orders, per product)

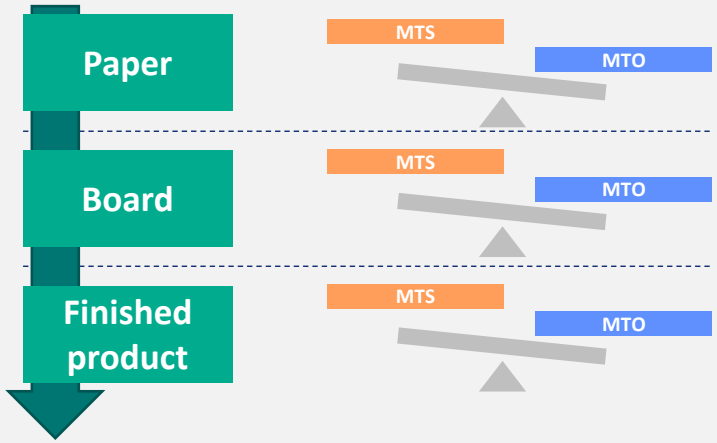
What-if levers (scenarios)

Operations levers

- Product allocation to plants
- Lines compatibility and lines availability (shifts, idle time,…)
- Historical setup times
- Minimum lot sizes
- Storage cap. (crane and fin. goods)

Analytically-based modelling

Optimal and automatic suggestion of the suitable **production strategy** for each **production stage**…



… **ensuring commercial and operational constraints** are **respected** (maximum lead time, lines and storage capacity, minimum lot sizes…)

Outputs

- **MTS/MTO/FTO mix**
- **Lot sizes** (for MTS products)
- **Lines occupancy**
- **Setups** no./duration
- **Stock levels** (and storage occup.)
- **Service level** agreement **accomplishment**
- **Impacted costs** (stocks, storage, obsolescence, change-over,…)
- **Lead time**
- **Multi-pallet threshold** (Impaper)

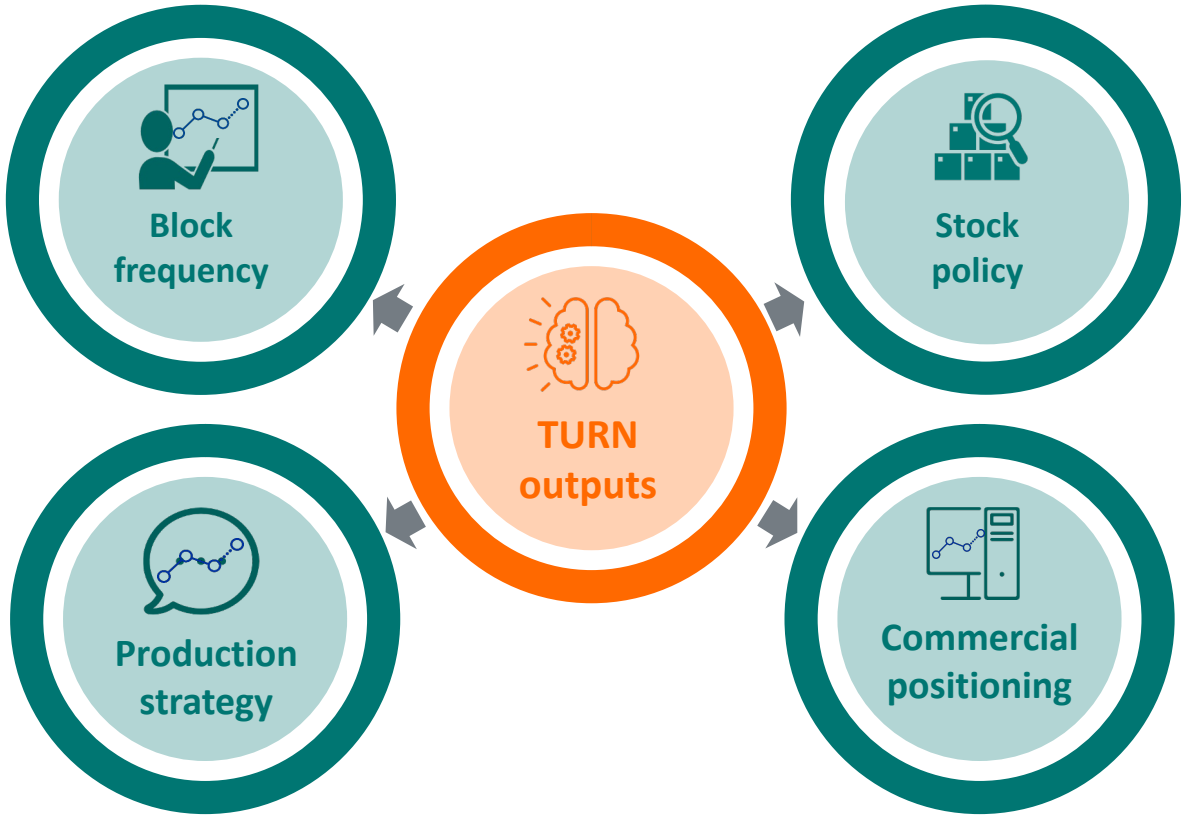
Defining a common ground of understanding between Marketing and Supply Chain

1 Parameterization granularity to be defined | 2 Allocation method to be defined

The TURN project proposes the optimal strategy for relevant Supply Chain and Marketing decisions

Project outputs

Optimal frequency to **balance setups and lot sizes** by block to alignment the **production wheel**



Safety stock and lot size definition to balancing production frequency and **storages utilization**

MTS/MTO/FTO decision by product and optimal **plant allocation** definition to minimize supply chain costs

Promised lead-time recommendation according to historical orders lead time and marketing inputs

Key ingredients to support Supply Chain and Marketing discussion and decision-making

The block and product decisions are considered simultaneously to ensure total synchronism between productions

Methodology – Block frequency and product strategy

Illustrative

Block frequency definition

	Block		
Block frequency	**7**	**14**	**30**
Block lot size (m3)	100	200	400
Monthly setup cost (k€)	4	2	1
% of demand known	95	90	50

1 - MTS products must have a production frequency smaller or equal than the block frequency

2 - MTO products keep the stock necessary to fulfill orders between block production and delivery date

The block and product decisions are considered simultaneously to ensure total synchronism between productions

Block frequency and product strategy

ILLUSTRATIVE

Block frequency definition

	Block		
Block frequency	**7**	**14**	**30**
Block lot size (m3)	100	200	400
Monthly setup cost (k€)	4	2	1
% of demand known	95	90	50

The **block frequency and product strategy are defined simultaneously** by assessing the impact in block sizes, setups, stock levels and commercial metrics

Production strategy definition

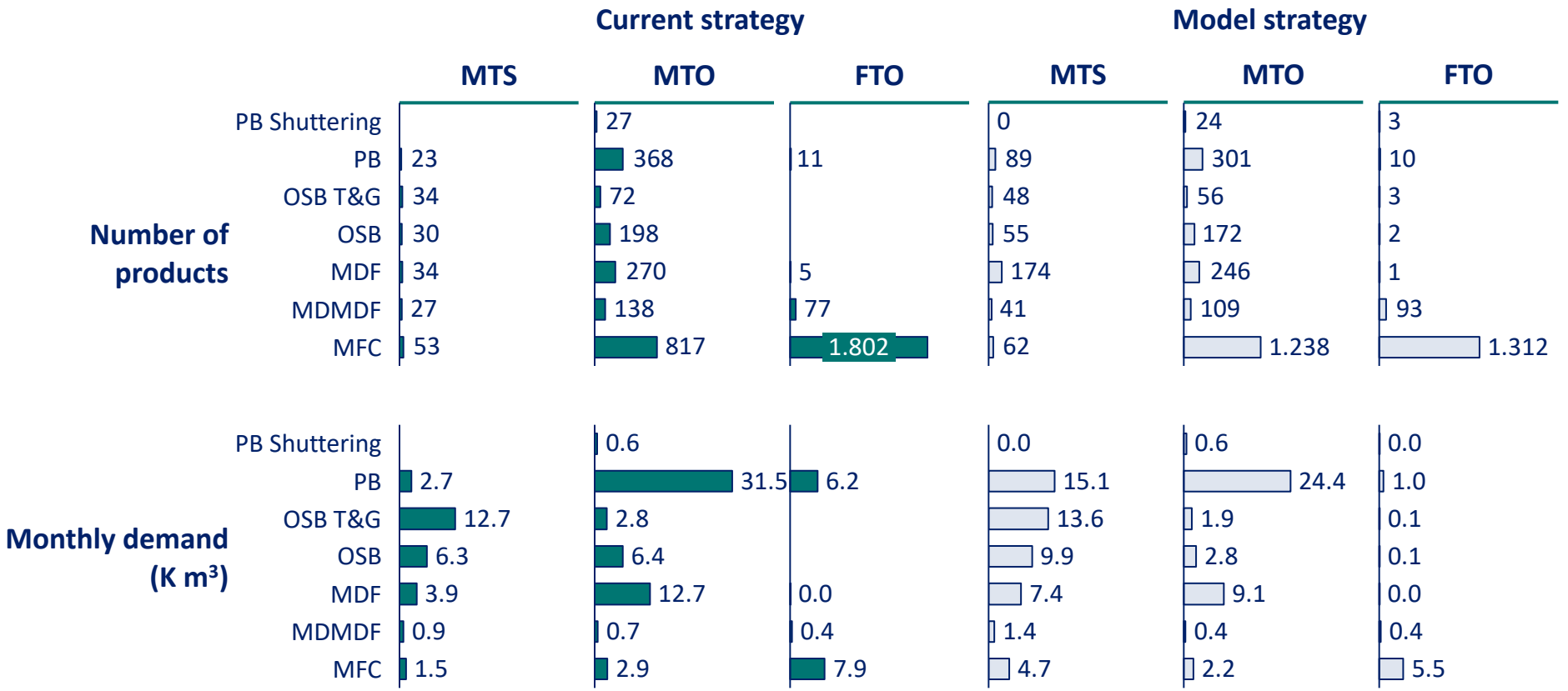
	MTS[1]			MTO[2]
Product frequency	**14**	**30**	**90**	**>14**
Average cycle stock (m3)	10	20	60	9
Safety stock (m3)	5	5	5	0
Promised lead time (days)	7	7	7	21

1 - MTS products must have a production frequency smaller or equal than the block frequency

2 - MTO products keep the stock necessary to fulfill orders between block production and delivery date

The proposed strategy depends on increasing the demand as MTS to decrease the impact of change-overs

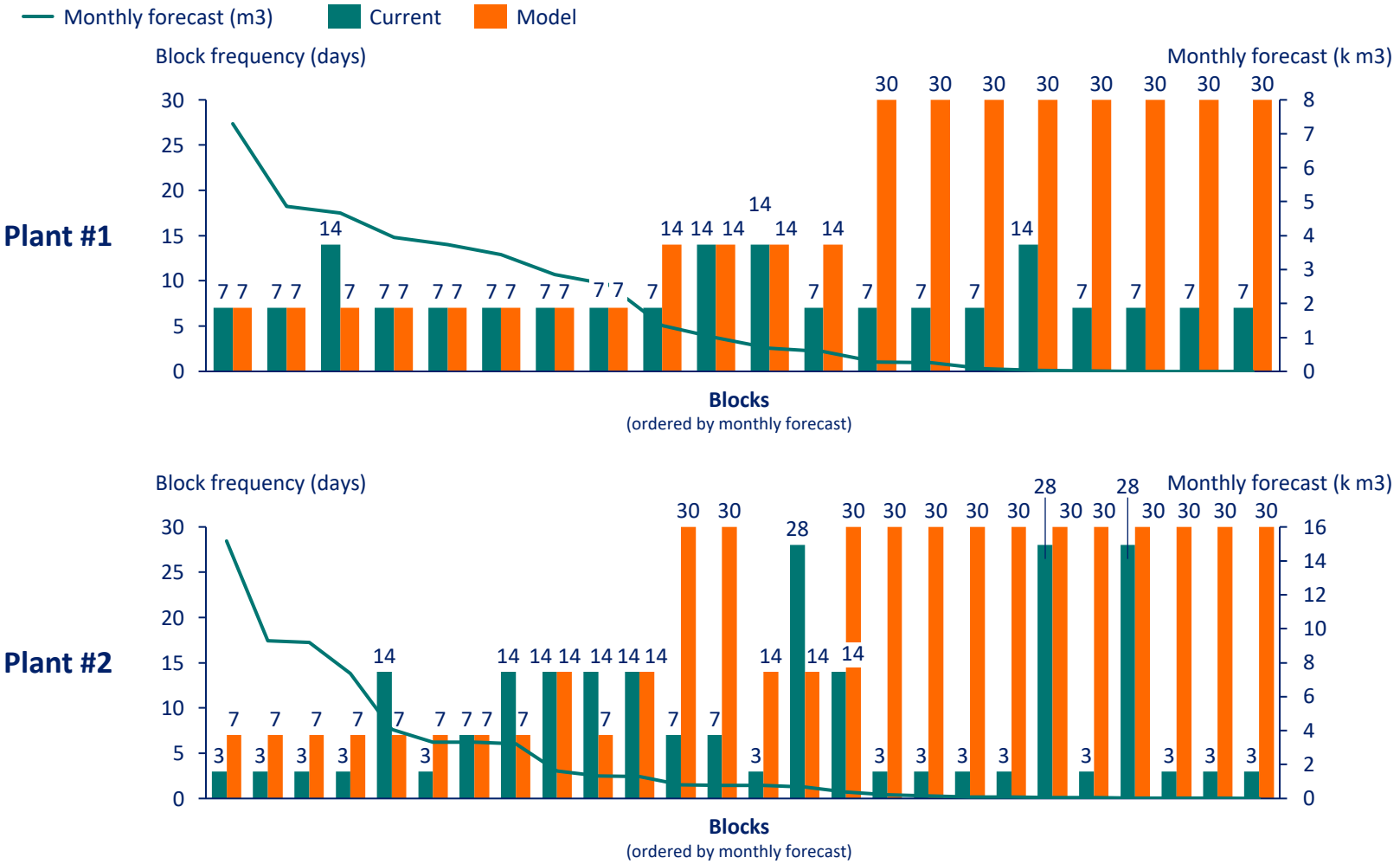
Strategy mix (finished products only)



- Transversal **increase of the share of demand as MTS** through the proposed strategy
- Increase the **MTS** prominence (SKUs and demand) in core grid levels as **PB, OSB and MDF**
- Decrease **MFC demand as MTO**, even though the number of products increase

The product blocks with higher demand should ensure an increased production frequency

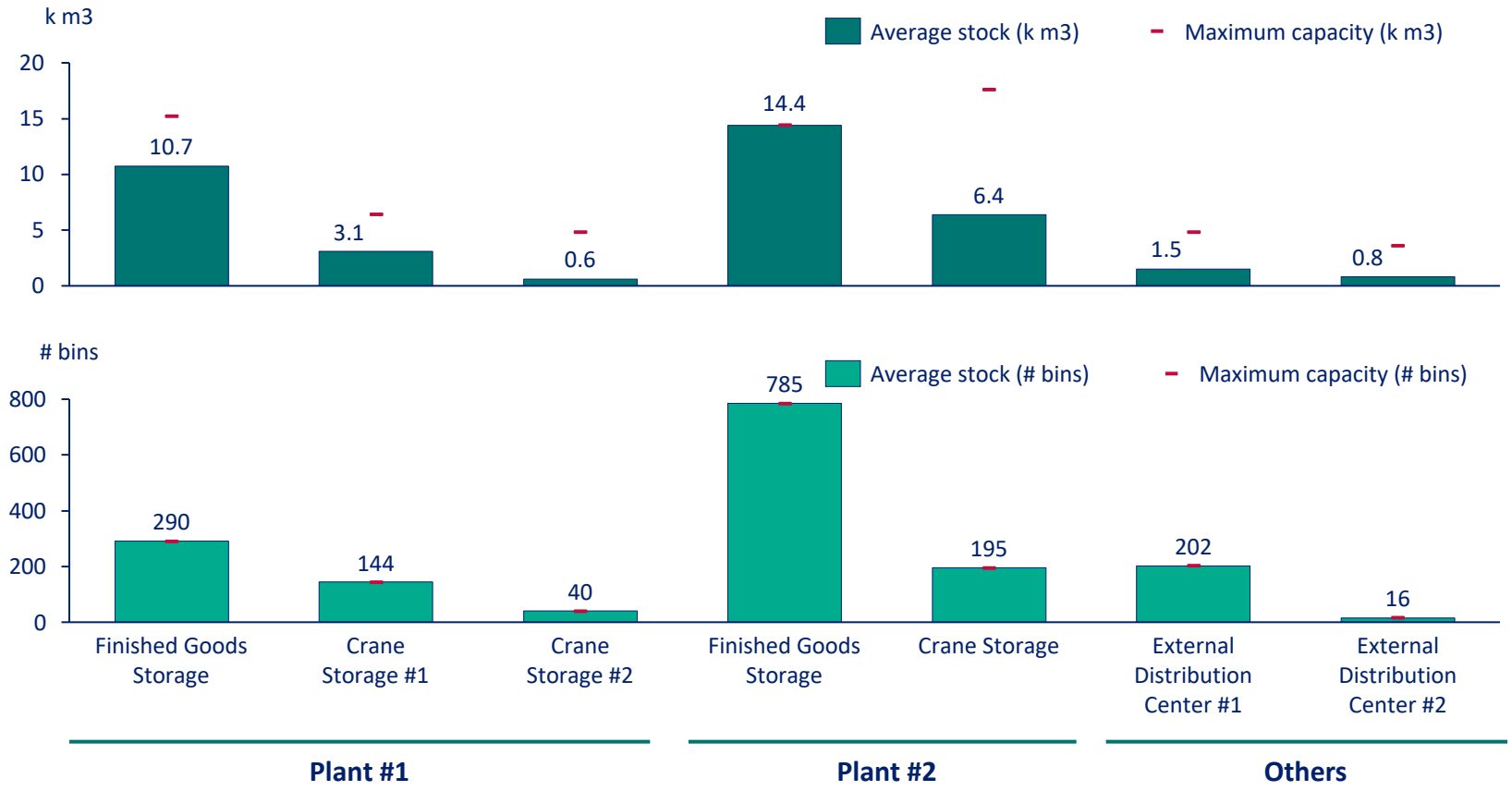
Block frequency distribution



- The proposed strategy ensures models with a **higher level of demand have a higher frequency**
- The increased frequency in products with greater demand **decreases the required stock levels in MTS** products and improves the time to deal with unexpected orders
- The decrease in **blocks frequency is linked to ensure larger lots** to products with low demand

Model MTS suggestion is limited by the available storage capacity (which limits higher service level values)

Storages utilization



- The models complies with storage limitations by considering the overall capacity in **m^3 and number of bins** (position)
- The model imposes a limitation of **one product per position**, even though **one product might use multiple positions**
- The **positions are fully occupied** which limits the capacity to store more volumes