U.PORTO
FEUP FACULDADE DE ENGENHARIA
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INESCTEC

HYBRID OPTIMIZATION/SIMULATION APPROACH FOR FLEXIBLE SUPPLY CHAIN MANAGEMENT

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Dissertação realizada no âmbito do Mestrado Integrado em Engenharia Electrotécnica e de Computadores

LIST OF CONTENTS

1 - INTRODUCTION

CONTEXT

- Market competitivity [1]
- Importance of supply chain design [2]
- Good stock management [3]
- Use of *additive manufacturing* [1]

[1] S. H. Khajavi, J. Partanen, and J. Holmström, "Additive manufacturing in the spare parts supply chain," *Computers in Industry*, Article vol. 65, no. 1, pp. 50-63, 2014.
[2] D. J. Garcia and F. You, "Supply chain design and optimization: Challenges and opportunities," *Computers and Chemical Engineering*, Article vol. 81, pp. 153-170, 2015.
[3] S. Moniz, "Operations management, Lecture TP9 – Managing inventories " November, 2016.

1. INTRODUCTION

MOTIVATION

- Evaluate new supply chain configurations
- Develop a decision support tool for supply chain managment

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1. INTRODUCTION

OBJECTIVES

- Develop of a optimization/simulation model
- Consider the use of 3D printers
- Evaluate new supply chain configurations

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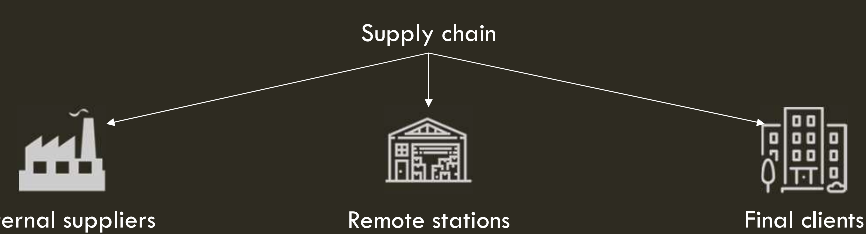
2 - CASE STUDY

2 CASE STUDY

Inserted in the European project FASTEN

A company intends to use 3D printers and evaluate the impact of it’s use



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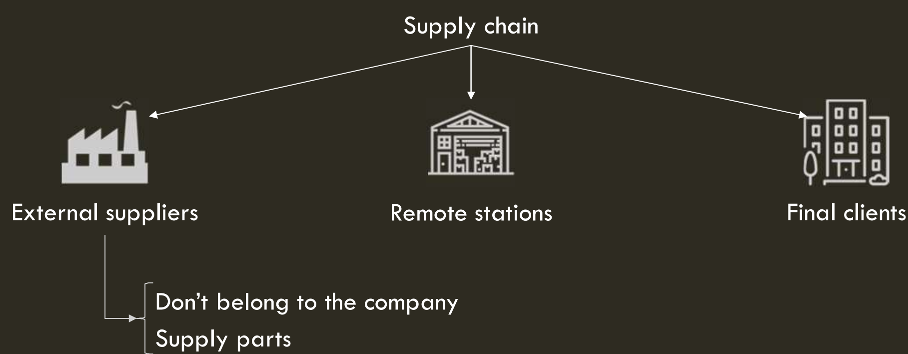

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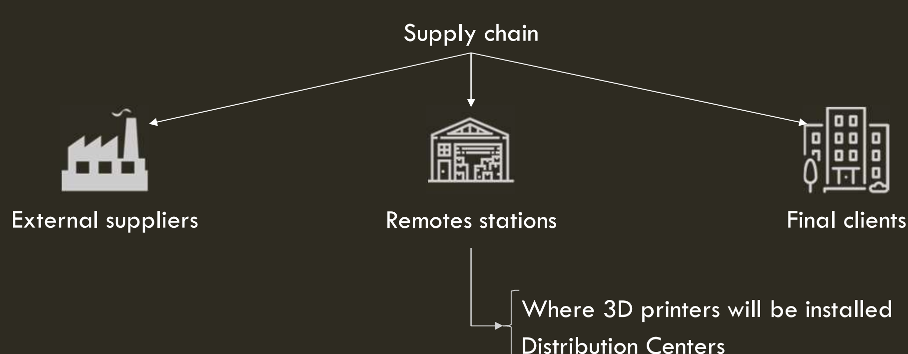
2 CASE STUDY

Inserido no projeto europeu FASTEN

Empresa pretende utilizar impressão 3D e avaliar o impacto do seu uso



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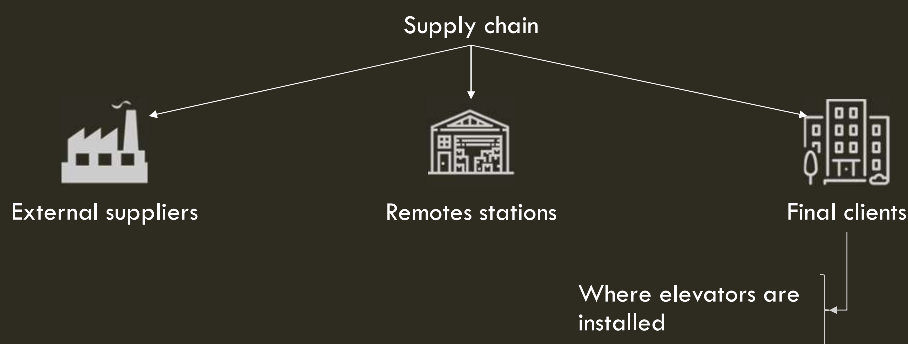
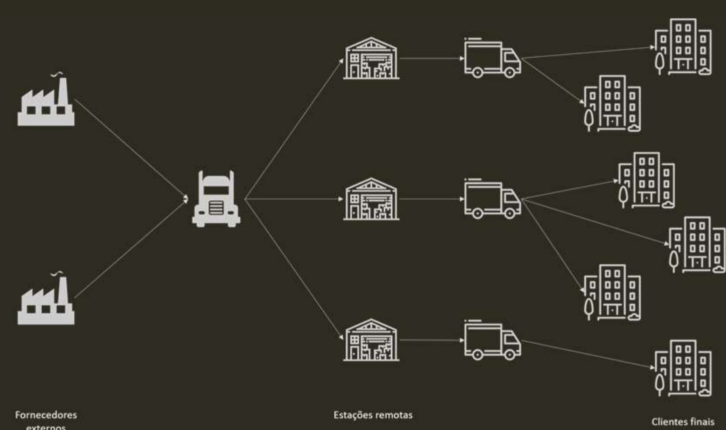


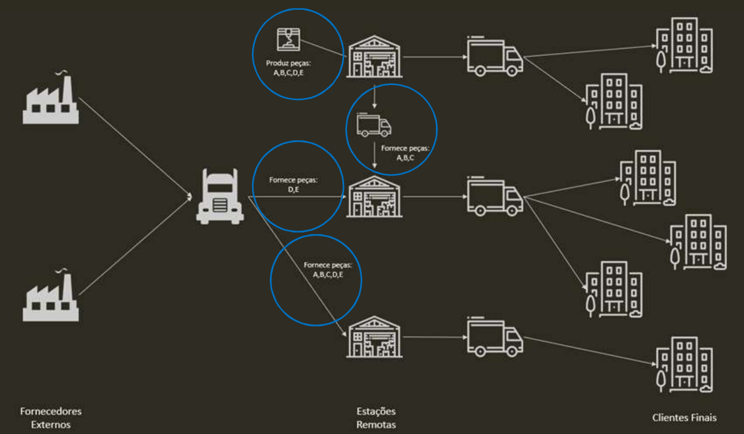
2. CASE STUDY

CURRENT SUPPLY CHAIN



2. CASE STUDY

SUPPLY CHAIN TO BE IMPLEMENTED



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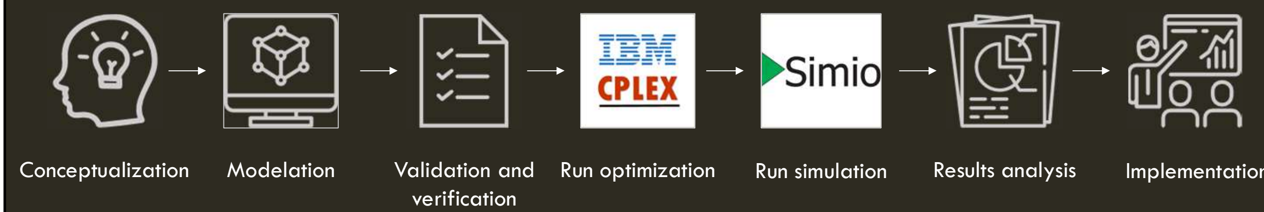
3 - METHODOLOGY

3 METHODOLOGY



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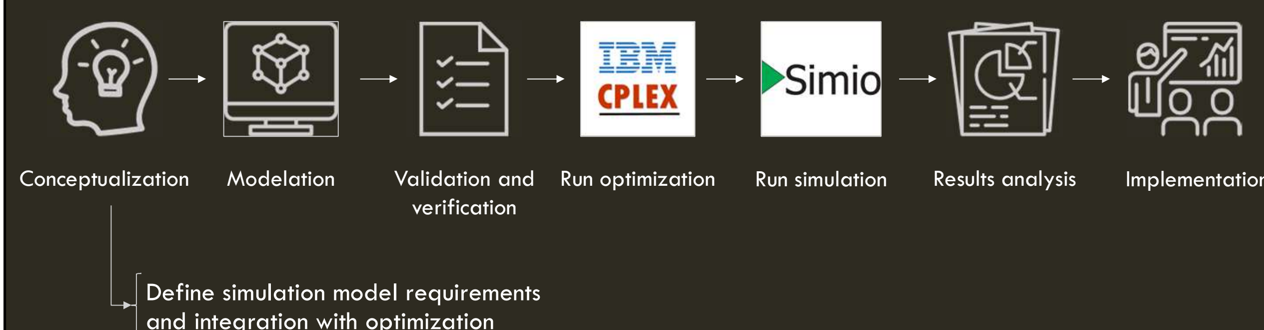
3 METHODOLOGY



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3 METHODOLOGY

Conceptualization → Modelation → Validation and verification → Run optimization → Run simulation → Results analysis → Implementation

Build the simulation model

3 METHODOLOGY

Conceptualization → Modelation → Validation and verification → Run optimization → Run simulation → Results analysis → Implementation

Test the simulation model na the integration with the optimization

3 METHODOLOGY

Conceptualization → Modelation → Validation and verification → Run optimization → Run simulation → Results analysis → Implementation

Running the optimization model for the case study

3 METHODOLOGY

Conceptualization → Modelation → Validation and verification → Run optimization → Run simulation → Results analysis → Implementation

Evaluate the performance of the supply chain

3 METHODOLOGY

Conceptualization → Modelation → Validation and verification → Run optimization → Run simulation → Results analysis → Implementation

Analysis and comparison of the results of both models

3 METHODOLOGY

Conceptualization → Modelation → Validation and verification → Run optimization → Run simulation → Results analysis → Implementation

3D printers, stock levels, capacities

4 - MODELS

OPTIMIZATION

Decision variables

- Suppliers
- Number of 3D printers
- Parts produced
- Stock levels
- Supplying parameters

4. MODELS

OPTIMIZATION

Constrains

- Number of 3D printers >= 0
- A remote station can only provide parts that produce
- A remote station can only produce for its own consumption and/or supply
- A station can't produce above its capacity
- For a part type, a station can only be supplied by a supplier or remote station

Objective function

Costs

4. MODELS

SIMULATION

Optimization

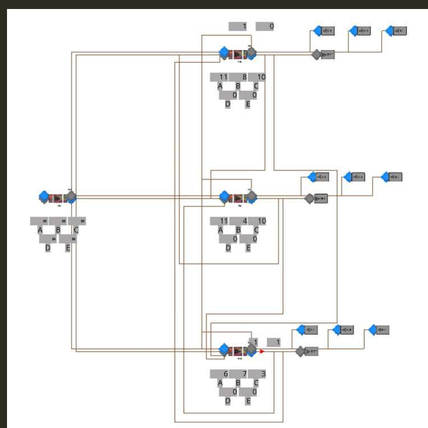
- Suppliers
- Number of 3D printes
- Parts produced
- Stock levels
- Supplying parameters

Simulation

- Simulation
- Monitorization
- Dashboards and tables

4. MODELS

SIMULATION MODEL



Configuration 1

- 3 Part types (A, B & C)
- 3 Remote stations (A, B & C)
- 1 External supplier (1)

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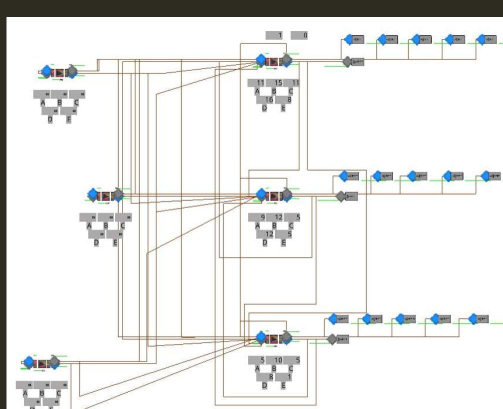
4. MODELS

SIMULATION MODEL



Configuration 2

- 5 Part types (A, B, C, D & E)
- 3 Remote stations (A, B & C)
- 3 External supplier (1, 2 & 3)

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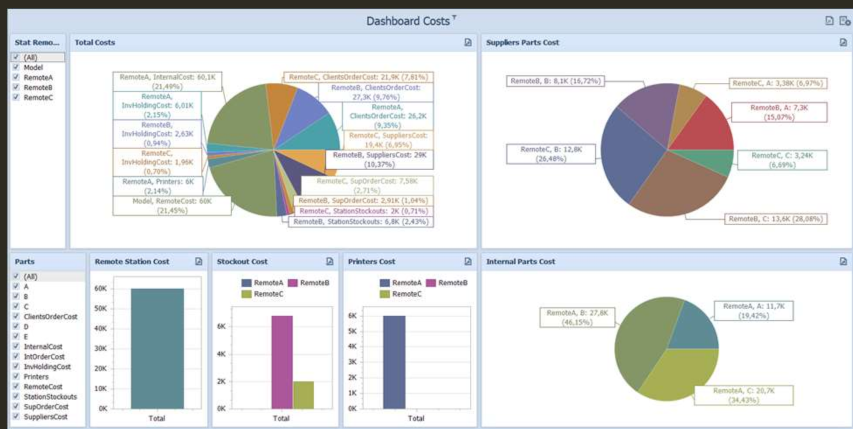
4. MODELS

COSTS DASHBOARD



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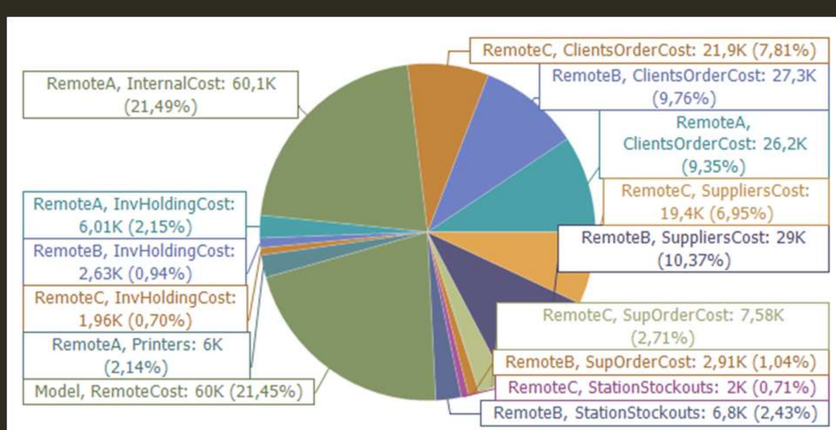
4. MODELS

COSTS DASHBOARD



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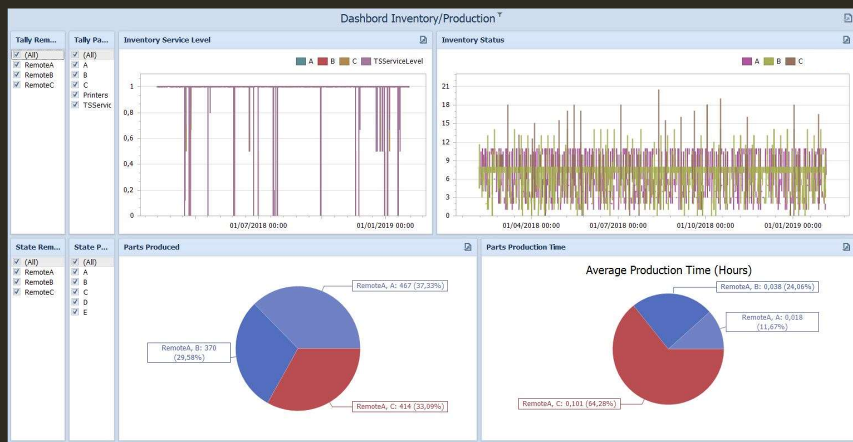
4. MODELS

INVENTORY/PRODUCTION DASHBOARD



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5 - IMPLEMENTATION OF THE METHODOLOGY

5 IMPLEMENTATION DA METHODOLOGY

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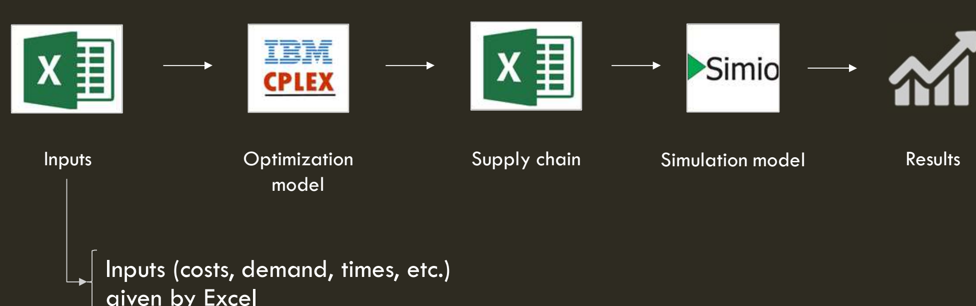

5 IMPLEMENTATION DA METHODOLOGY

Inputs → Optimization model → Supply chain → Simulation model → Results

Running the optimization models with the inputs

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5 IMPLEMENTATION DA METHODOLOGY

Inputs → Optimization model → Supply chain → Simulation model → Results

Suppliers, number of 3D printers, stock levels, capacities, etc. saved on Excel

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5 IMPLEMENTATION DA METHODOLOGY

Inputs → Optimization model → Supply chain → Simulation model → Results

Simulation model executed with the optimization results

5 IMPLEMENTATION DA METHODOLOGY

Inputs → Optimization model → Supply chain → Simulation model → Results

Results visualization

6 - RESULTS

6. RESULTS

TEST SCENARIOS

Scenario	3D printers type	Configuration	Localization

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6. RESULTS

TEST SCENARIOS

Scenario	3D printers type	Configuration	Localization
1	Actual	1	A

RESULTS

6 TEST SCENARIOS

Scenario	3D printers type	Configuration	Localization
1	Actual	1	A
2	Advanced*	1	A e C

*2x faster and half of the cost

6. RESULTS

TEST SCENARIOS

Scenario	3D printers type	Configuration	Localization
1	Atual	1	A
2	Advanced*	1	A e C
3	Actual	2	A

*2x faster and half of the cost

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6. RESULTS

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TEST SCENARIOS

Scenario	3D printers type	Configuration	Localization
1	Atual	1	A
2	Advanced*	1	A e C
3	Actual	2	A
4	Advanced*	2	A

*2x faster and half of the cost

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6. RESULTS

RESULTS DO CASE STUDY

Lead time

Scenario			
1	2	3	4
5,1h	4,7h	4,8h	4,8h

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6. RESULTS

RESULTS DO CASE STUDY

Service level

Scenario			
1	2	3	4
96%	97%	98%	98%

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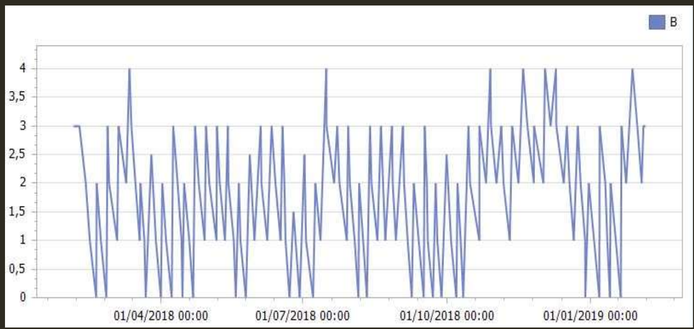
6. RESULTS

RESULTS DO CASE STUDY

Inventory status



Scenario 1: Inventory of part B in remote B

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6. RESULTS

RESULTS DO CASE STUDY

Total cost

Scenario	Optimization	Simulation
1	€ 225 430	€ 237 514
2	€ 192 242	€ 200 849
3	€ 346 291	€ 348 844
4	€ 288 111	€ 297 303

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6. RESULTS

RESULTS DO CASE STUDY

Scenario 1 costs

Costs	Optimization	Simulation
Fixed	€ 66 000	€ 66 000
Orders	€ 159 135	€ 162 594
Inventory	€ 295	€ 440
Stockout	€ 0	€ 8 480
Total	**€ 225 430**	**€ 237 514**

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7 - CONCLUSION

7. CONCLUSION

CONCLUSIONS

- The tool developed (which integrates optimization and simulation) helps design supply chains
- The obtained results allowed to verify that well located 3D printing improves the lead time and the service level

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7. CONCLUSION

FUTURE DEVELOPMENTS

- More detailed transports simulation
- Consideration of maintenance teams

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THANK YOU

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