POLITECNICO DI TORINO – GRENOBLE INP

Master’s degree course in

Management Engineering

and Supply Chain

Master’s degree Thesis

Evaluation and optimization of the sustainability performances in Inbound Transportation

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Preface

This report has been written during the 3rd semester of the Double Degree program in "Management Engineering and Supply Chain", in accordance with Politecnico di Torino – Italy - and Grenoble INP – Génie Industriel - France. It has been conducted at Nike ELC, in Laakdal – Belgium – during a 5-months internship period that took place from September 2nd, 2019, to February 2nd, 2020. Also, it's part of the Inbound Transportation team of Transportation, Customs and Procurement department, and aims at evaluating and optimizing its sustainability performances.

Firstly, I'd like to thank all the people I've interacted with at Nike ELC, especially Karen Thoonen, DC Inbound Transportation Manager, Jennifer Poulsen, Sustainability Manager at Nike Global, Konstantinos Papoutsis, Logistics Sustainability Lead, and the entire Inbound team for the valuable feedback and discussions as well as for their always shown availability.

In addition, a special thanks to both my supervisors, Paolo Claudio Priarone and Gülgün Alpan, for their assistance throughout the entire internship period. Their help has been of inexpressible importance, especially at the beginning of the internship, guiding me through the organization of each phase of the work, but more generally giving me critical feedbacks at each checkpoint line.

Manfredi Virdone

Laakdal, Belgium, February 2nd, 2020

Summary

Greenhouse-gas-emissions are the main responsible for global warming: the more they're emitted, the more the Earth is heated, and environmental disasters may arise. Consequently, people have been started to worry more and more about the footprint they leave on the Earth and to be more concerned about how companies are monitoring their own.

As the world's largest sports brand supplier, to maintain its leadership in the market, Nike has always wanted to seek initiatives that could increase its prestige and fame while aligning with what its customers' needs are. Therefore, on a sustainable level, Nike committed to a lot of initiatives such as the Paris Agreement to fight climate change issues or becoming a member of the UNFCCC to reduce its carbon footprint.

In order to reach the targets set both by the agreements – externally – and the company itself, – internally –, Nike has started to tackle sustainability topics in each branch of its business, among which in the transportation sector.

The objective of this report is to determine, for the EMEA geo at Nike ELC, what can be done upstream the supply chain, in the Inbound transportation, to reach those targets, making the carbon footprint part of the company business decisions. Therefore, the main research question focuses on the evaluation and optimization of the actual volume allocation process for maritime transports. In fact, when it comes to split the volumes among the different LSP's, Analysts from the team make it considering cost and time variables, risk mitigation and delivery performances of the carriers, not caring about the impact they have on the environment. The answer to this question shows that making sustainability part of such a business process would not only reduce the company's $CO2_e$ emissions, but it wouldn't even heavily affect the other main decision variables, complying with what are the constraints the company wants to stick to.

In line with the first question, a second one provides insights on future alternatives that could contribute, alongside the optimization of the allocation process, to reach the reduction targets the company set. Results arisen from desk researches show that there are three main alternative fuels that could help the company to beat the goals and that would need to be approached in different timeframes, from short to long-term. They're respectively LNG, Biofuels and Hydrogen.

Abbreviations

AF	=	Air Freight
APLA	=	Asian Pacific and Latin America
DC	=	Distribution Center
Decon	=	Deconsolidation Center
DRS	=	Direct Shipments
ELC	=	European Logistics Campus
EMEA	=	Europe, Middle East and Africa
FEU	=	Forty Foot Equivalent Unit
FY	=	Fiscal Year (it goes from June 1st to May 31st)
GC	=	Greater China
GFP	=	Goods Flow Planning
GHG	=	Greenhouse Gas
GWP	=	Global Warming Potential
LSP	=	Logistic Service Provider
NA	=	North America
ROE	=	Rest of Europe
SE	=	Sea-Air
TEU	=	Twenty Foot Equivalent Unit
TCP	=	Transportation, Customs and Procurement
TR	=	Truck
UNFCCC	=	United Nations Framework Convention on Climate Change
VL	=	Vessel
WHQ	=	World Head Quarter

WTW	=	Well-To-Wheel (energy consumption from the mining phase to a vehicle being driven)
YTD	=	Year-To-Date

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1 Introduction

The following study has been conducted together with the worldwide-known sports brand, Nike Inc.

Founded in 1964 as Blue-Ribbon Sports by Bill Bowerman and Phil Knight (Jonathan, 2014), becoming Nike Inc. after seven years, in 1971, the company is the world's largest supplier of footwear, apparel, and equipment. It counts about 40 origins and 700 factories all over the world (Appendix 1) spread among four geos: EMEA, APLA, GC, NA. The WHQ is located in Beaverton, Oregon, Portland. Through the years, Nike has always continued to expand, making some important acquisitions as, for example, the surf apparel company Hurley, in 2002, and the worldwide known sneakers company Converse, in 2003. Nike's mission is very simple and clear:

"Bring inspiration and innovation to every athlete"*

*If you have a body, you're an athlete.

1.1 ASAP Strategy

In order for Nike to bring its mission into life, the "Athletes Serving Athletes Personally" (ASAP) strategy vision is created. It includes three main concepts as well as areas where the company wants to focus that are 2X Service, 2X People and 2X Innovation (Fig.1).

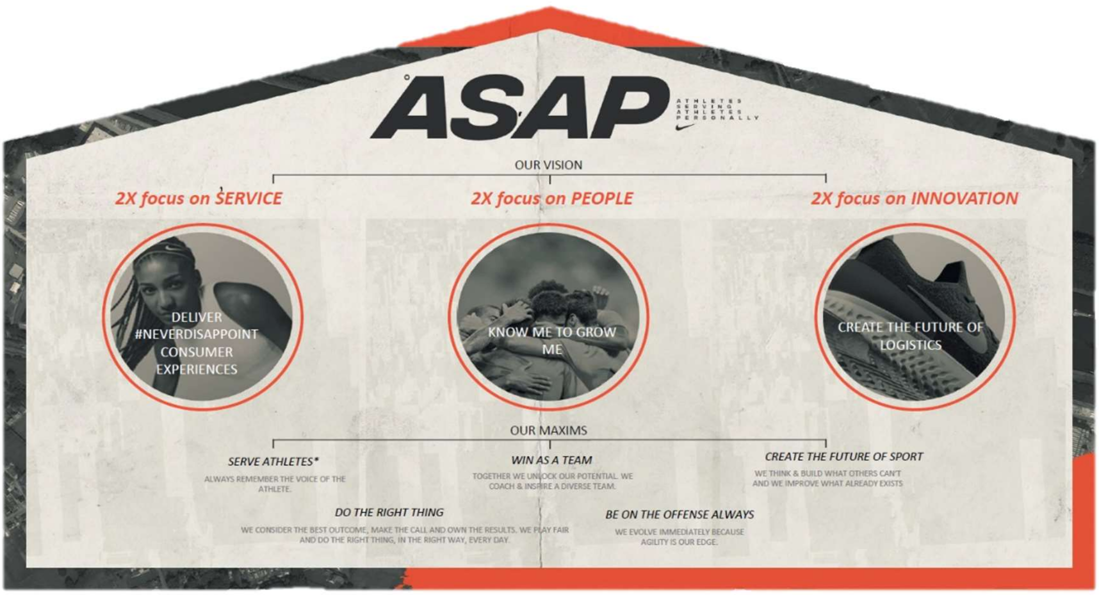

Fig.1 ASAP Strategy. Source: Introduction to Inbound Transportation

The core concept of the company is strictly linked to what are defined as its values, commonly known as the "5 Maxims":

1) *Serve Athletes*

   The key belief of the company is to do what they do with the main objective to help athletes to achieve their full potential, inspiring and considering them, putting their voice above everything.

2) *Create the Future of Sport*

   Be always proactive, optimists, dreamers, and inventors. What gives Nike the leadership in its market is the thought that there is no finish line; there's always something that can be improved, new disruptive inventions and businesses that can be created.

3) *Be on the Offense Always*

   Closely related to the above maxim, the company doesn't want to fix a limit where it can arrive. It's always a matter to dream big, making big objectives even bigger. The idea is: "Play by the rules but be ferocious".

4) *Do the Right Thing*

   To be a leader, you have to think like a leader. Here, the maxim distinguishes what is management – do things right - from what is leadership – do the right things (Covey, 1989).

5) *Win as a Team*

   Dare to run an unbeatable offense, together. Nike always drafts the best players, where the word "best" doesn't mean the strongest, but those who play with heart and courage, and inspire teams where everyone contributes to the win.

1.2 Nike in numbers

Globally, Nike counts around 76000 employees, with a global revenue of 39.1 billion USD in FY19 (Fig.2), showing a clear growth of 7,5% and a net income of 4.03 USD, increasing of about the 210% compared to the previous FY (O'Connell, 2019).

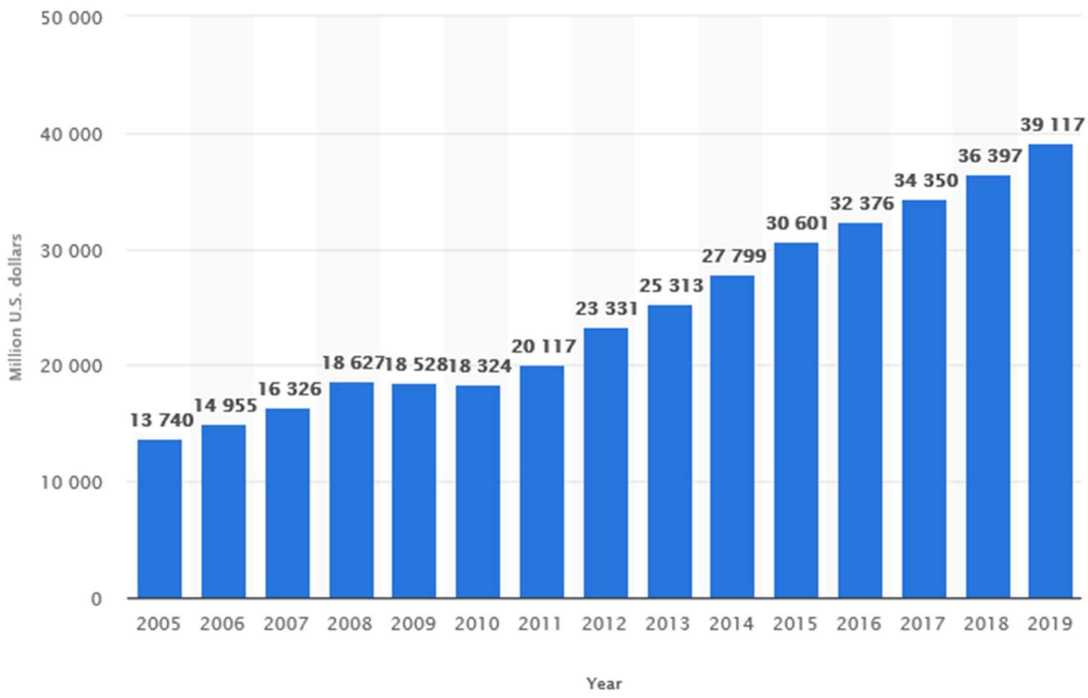

Fig.2 Nike's worldwide revenue from 2005 to 2019. Source: Statista

1.3 Nike ELC

An important location for Nike, responsible for the EMEA regions, is the ELC, located in Laakdal, Belgium (Appendix 2). Here, there are around 3500 full-time employees, which number grows to more than 5000 during peak periods. This center is the core of all European logistics operations conducted for Nike. Containers from overseas arrive either at the port of Antwerp or Rotterdam and are then delivered via barge, mostly, or truck to this facility. Here the products are being sorted to eventually be delivered to the retail stores, retail warehouses or to the final customer.

Nike has chosen this location due to amongst other factors its favorable geographical position as 80% of its customers are situated within a 700 km range from this facility. Secondly, this gives them quick access to various modes of transport, as the highway is just in front of the facility, the barge canals behind the warehouses and the train tracks and airport are also both located nearby.

Focusing on EMEA numbers, the geo has contributed for 25% of the total revenue of FY19 (Nike, Investors News Details, 2019), generating 9.81 billion USD (Tab.1).

NIKE, Inc.
DIVISIONAL REVENUES
(Unaudited)

(Dollars in millions)	THREE MONTHS ENDED 5/31/2019	THREE MONTHS ENDED 5/31/2018	% Change	% Change Excluding Currency Changes[1]	TWELVE MONTHS ENDED 5/31/2019	TWELVE MONTHS ENDED 5/31/2018	% Change	% Change Excluding Currency Changes[1]
North America								
Footwear	$ 2,736	$ 2,525	8 %	9 %	$ 10,045	$ 9,322	8 %	8 %
Apparel	1,275	1,207	6 %	6 %	5,260	4,938	7 %	7 %
Equipment	154	143	8 %	7 %	597	595	—%	—%
Total	4,165	3,875	7 %	8 %	15,902	14,855	7 %	7 %
Europe, Middle East & Africa								
Footwear	1,643	1,625	1 %	11 %	6,293	5,875	7 %	12 %
Apparel	713	741	-4 %	5 %	3,087	2,940	5 %	9 %
Equipment	101	100	1 %	10 %	432	427	1 %	5 %
Total	2,457	2,466	—%	9 %	9,812	9,242	6 %	11 %

Tab.1 Nike's divisional revenue FY19. Source: investors.nike.com

1.3.1 The TCP department

Among all the existing departments in the campus, the main one includes Transportation, Customs & Procurement (TCP). Concerning transportation, it consists of two teams: Inbound (Appendix 3) and Outbound. The Inbound team is responsible for the deliveries of all the produced volumes from factories to the DC's, deconsolidation centers and "Direct-Direct" customers (Fig.3).

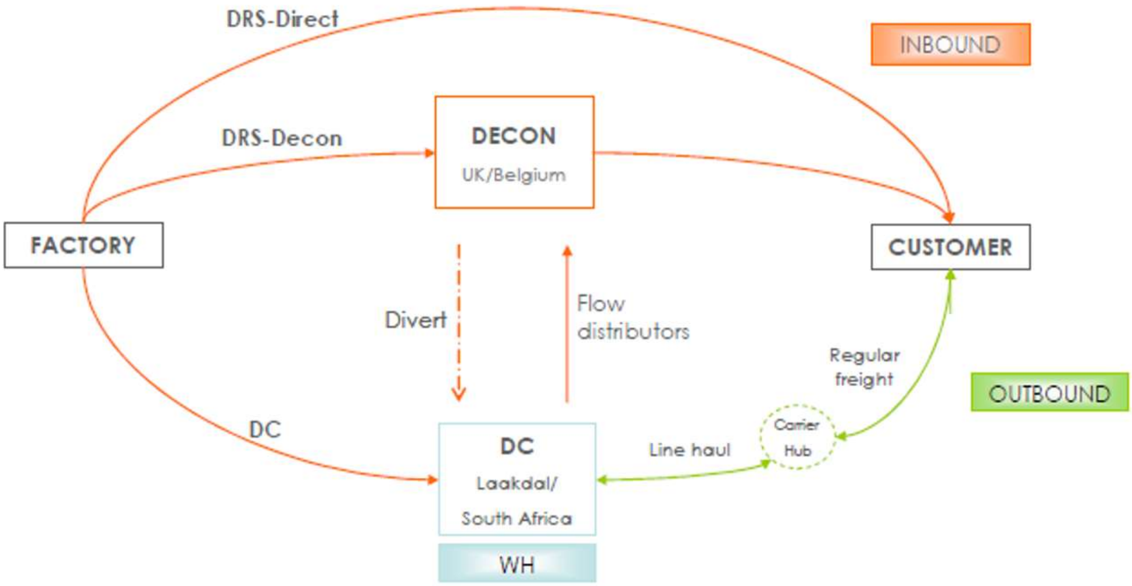

Fig.3 EMEA flows. The Inbound team is responsible for the orange colored lines. Source: Introduction to Inbound Transportation

To do so, different means of transport are used such as ships, planes, trucks, and barges. The Inbound vision is to make the product available at the right place, at the right time, in the most efficient way and, since few years, in the most sustainable way, with the aim to establish an end-to-end accountability, leaving the market to drive the flow (Croes, 2019).

1.4 Sustainability at Nike

Nike was one of the first companies to realize, in the mid-'90s, that sustainability and environmental impact could have been key business factors for the future (Nike, 2019). Therefore, after the early 2000s, they started to look at sustainability as a source to gain a competitive advantage on other companies.

Hence, tackling mainly 4 fronts - Waste, Carbon and Energy, Water and Chemistry -, the company changed its view, achieving important results. Among them, for example, the partnership made in 2015 with RE100, a company whose aim is to run 100% renewable energy facilities, to run renewable energy in all Nike's structures by 2025 or the usage of recycled polyester for making new products, that leads to a 30% reduction in CO_2 emissions compared to virgin one (Nike, 2012).

To put it in facts, in 2015, Nike has been recognized as the sustainability leader on the Sole Sustainability Index (SSI), an index that measures how companies from the same sector perform according to certain criteria as, for instance, social and environmental performances (Fig.4).

Fig.4 SSI scores. Source: Sustainable Innovation 101

1.4.1 Nike and the UN Climate Change and Fashion Industry Charter for Climate Action to mitigate GHG emissions

Greenhouse-gas-emissions are the main responsible for the global warming; their main aim is to keep the Earth warm, but as every exaggeration, the more they're emitted the more the Earth is heated, causing environmental disasters such as the acceleration of the melting of polar ice caps and the increase of sea levels. Estimates state that, due to the global warming, average sea levels will rise between 20 and 200 cm in the actual century (Erlandson, 2008) To tackle these threats, an agreement has been signed in 2016, in Paris, within the UNFCCC, trying to put in place actions to mitigate the GHG emissions' effects.

The agreement (UNFCCC, 2015) declares that its aim is to decrease global warming through holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change.

Hence, Nike wanted to monitor its carbon footprint by first calculating the corporate "carbon budget" (amount of carbon dioxide that can be emitted remaining under the 2°C threshold) to then realize that keep doing its business, they couldn't fit with climate stability, far exceeding the carbon budget by 2025 (Fig.5).

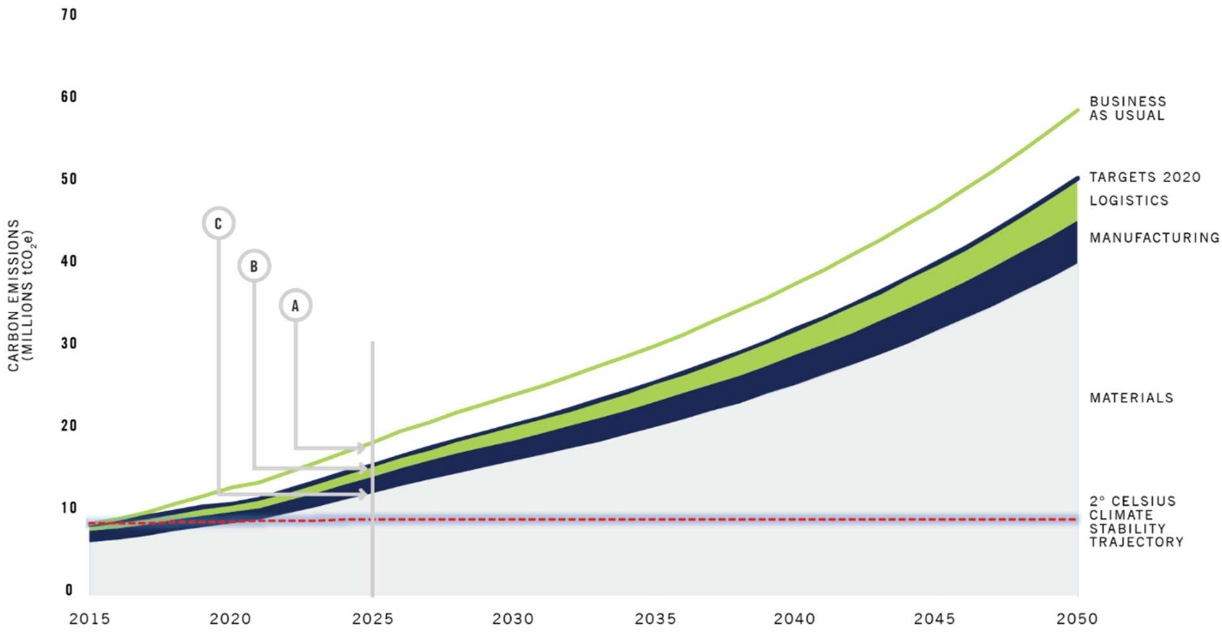

Fig.5 Carbon budget trend until 2050. Source: Sustainable Innovation 101

Therefore, in June 2019, Nike decided to join the UNFCCC, signing the Fashion Industry Charter for Climate Action (Nike, 2019). This is an agreement where all the participants are committed to achieve two precise goals:

1) Reduce aggregate GHG emissions by 30% by 2030;
2) Achieve GHG free emissions by 2050.

Also, the company established a climate change tackling program called "Move to Zero" (Nike, 2019).
There are several initiatives that Nike wants to put in place and others that have already been implemented such as:

1) Run 100% renewable facilities by 2025;
2) Divert 99% of the entire footwear manufacturing waste from landfill;
3) Divert more than 1 billion plastic bottles per year from landfill to create parts of the base of new jerseys and Flyknit shoes;
4) Launch of "Reuse-A-Shoe" and "Nike Grind" programs to convert waste into new products, playgrounds, running tracks and courts.

1.4.2 Sustainability at Nike ELC

Opened in 1994 as the European Customer Service Centre, focusing on sports apparel, ELC is now the core of all the operations that Nike conducts in the EMEA regions.

It includes five distribution facilities across Ham, Laakdal, and Meerhout areas, in Belgium. One of the key concepts of the campus is to always look for sustainable solutions, from a high (e.g. use of renewable energy to power the facilities) to a low-level point of view (e.g. use of aluminium canteen to avoid the utilization of cups, that are however already carton made).

Some of the most important changes that have been done so far include:

1) Utilization of 100% renewable energy, locally generated through wind, solar, geothermal, hydroelectric and biomass sources;
2) As previously mentioned in par. 1.2, the location is strategic; the network canals behind the building facilitate the usage of barges instead of trucks to reach it, heavily impacting the reduction of CO2 emissions. Estimations state that around 14000 trucks journeys per year are avoided (Nike, 2019);
3) More than 95% of the waste generated on-site is recycled (Appendix 4).

Furthermore, a new distribution center called "The Court" opened in 2019. Among the many innovations, it runs renewable energy from the previously cited sources and its warehouse has been built minimizing the utilization of steel and concrete, then also minimizing wastes and material usage.

2 Challenge definition

The aim of this chapter is to move from a general overview of Nike to a detailed description of the challenge that has been faced, presenting the business point of view of the company, analyzed and compared to what has been extracted from a literature research, as well as the research questions tackled, and the methodology applied to answer to them.

2.1 Challenge description

The "5Ws and How" model is usually used in journalism and research to gather all the possible information needed to make a complete analysis of a determined problem or challenge (Hart, 2002). Within the project, its main aim is to explain, besides the parties - or stakeholders - involved, how did and how is Nike ELC tackling sustainability from a purely practical point of view, and how is sustainability taken into account when a decision needs to be taken.

Hence, the final purpose of the paragraph is to define the ultimate goal of the project:

Nike has an ambitious target to reduce $CO2_e$ emission by 20% by the end of FY2020. What can be done in the Inbound space to support this goal? How can the carbon footprint be made part of business decisions?

2.1.1 The 5Ws and How

- *What was the challenge?*

According to the McKinsey Report (EMEA Sustainability Team, 2019), sustainability topics have started and are always more and more concerning all the people in the world, from consumers to employees. Therefore, to maintain its leadership as a sports brand, almost one year earlier, when the UNFCCC agreement was signed, Nike started taking actions to be greener.

What the company wants to do is to be more sustainable along its entire supply chain. That's why at ELC, a growing interest in the topic started emerging, especially in the Transportation team.

The goal Nike has set for the entire team is to reduce, by the end of FY20, the $CO2_e$ emissions by 20%, and there are multiple reasons to explain that.

One is that this goal has been set to align with what are the objectives of the UNFCCC. The other, the Logistics Sustainability Lead Konstantinos Papoutsis (Papoutsis, EMEA

Sustainability View, 2019) says, is to do something ambitious but achievable. This decision comes from experiences, trends, and estimations.

From an Inbound perspective, the challenge aimed to investigate ways to reduce the $CO2_e$ emissions for the transports from the origins either to ELC or to the customers, using a software that has been implemented at Nike in 2017, called LogEC. It is a tool that can help companies to analyze, in an efficient and certified way (compliant to the DIN EN 16258 standard and the French decree 2011:1336), their carbon footprint, allowing its users to run different type of reports, sorting them per fiscal year, fiscal period, product engine, shipping type, selecting the specific type of emissions the charts have to show.

- *Who tackled it?*

This project has been launched from the Inbound team, so almost all the people there were involved. However, the main people concerned were one of the two Inbound Transportation Manager as well as the co-supervisor of the thesis, Karen Thoonen, one Transportation Analyst, the Logistics Sustainability Lead, two people from Nike Global, the Sustainability Director, Samantha Callas, and the Sustainability Manager, Jennifer Poulsen, as well as yours truly.

Externally to the company, all the LSP's that are responsible for the Inbound deliveries have been interested in the analyses.

- *Why was it a challenge?*

All the analyses that will be shown in this report have two main objectives: contribute to the achievement of the 20% reduction target for the FY20 in the short-term while aligning with the objectives of the UNFCCC agreement in the mid/long-term.

The main reason why it was a challenge is that the latest data from FY2019-FY2020 states that the entire Transportation department at Nike ELC has reached a $CO2_e$ emissions reduction on a YTD basis in November of 6% (Fig.6), still far from the target. Among the reasons why Nike is struggling to reach the target, there is the continuous business growth that is going beyond the expectations and the low industry adoption of future fuels (Nike, Sustainability Alignment, 2019).

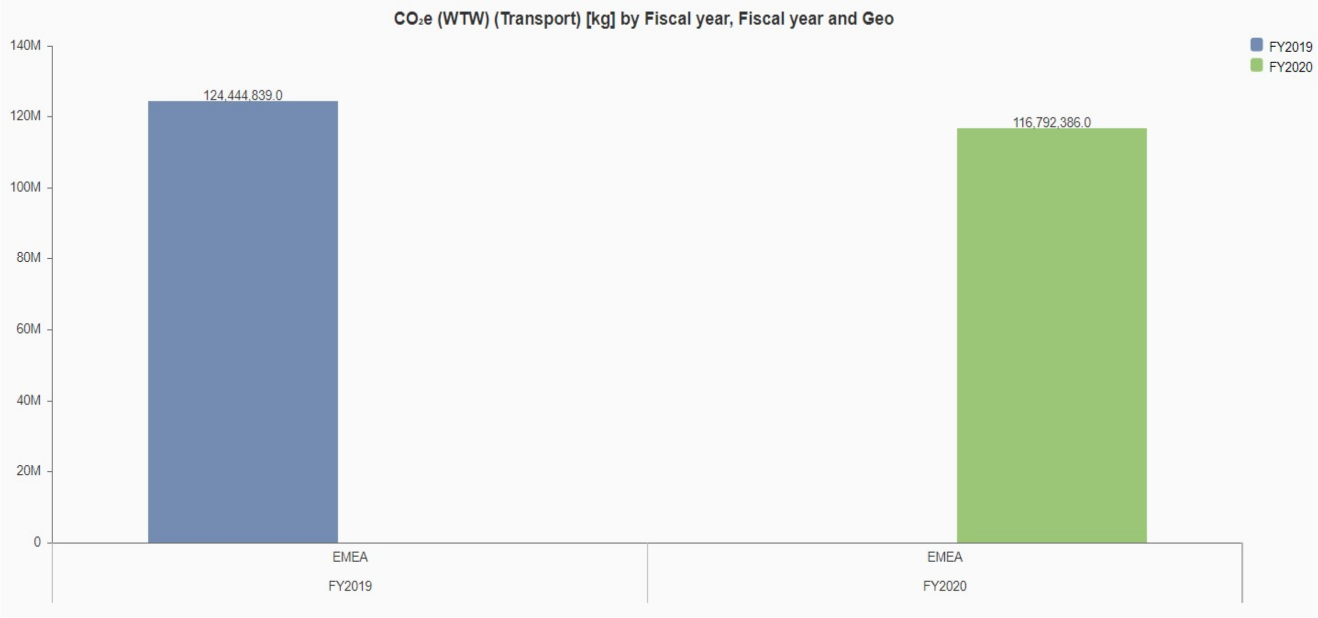

Fig.6 $CO2_e$ (WTW) emissions' comparison. Source: LogEC

Moreover, when the Inbound analysts had to split the rates of allocation for the FY20 expected volume among all the LSP's, they did it looking at costs, transit time, risk mitigation, number of sailings per week, not caring for the sustainable aspect. Hence, this could be one of the reasons why they are still far from the FY20 reduction target.
Thereby, the idea to make such analysis was to let the people inside Nike to be aware of the impacts that sustainability can have on the business, trying to make it a driver as equal as the previously mentioned when business decisions have to be taken.

- *Where did it occur?*

The project took part in the Inbound Transportation team at Nike ELC in Laakdal, Belgium.

- *When did it occur?*

Almost at the beginning of the FY20, in June 2019, when Nike decided to take strong actions to influence its carbon footprint, starting to look for alternative fuels to power their carriers and wanting to make sustainability one of the main drivers, both for Inbound and Outbound Transportation.

- *How was it handled?*

The project was divided into three main phases:

1) Desk researches, whose main aim was to get, on one side, knowledge about the history of the company and the way it has tackled sustainability since now, and on the other one, to find literature that could support the ultimate goal of the project;
2) Interviews, to dig deeper into the challenge and gather different opinions from all the parties involved, with the aim of understanding why is sustainability one of the main topics the company wants to tackle;
3) Evaluation of the actual situation through the realization of different analyses that led afterwards to the implementation of a tool that could optimize the sustainable performances of the Inbound team on a maritime transport level.

2.2 Business challenge

What this paragraph wants to highlight is: "How is Nike ELC tackling sustainability from a logistic perspective? How is the Inbound Transportation team doing it? Do managers take business decisions based on sustainable results? Is there a literature behind that can testify it?

2.2.1 Literature Review

In the past two decades, since climate change started becoming an important public policy issue, companies felt pushed to reset their strategies and their way of work considering their environmental print. Studies from Bansal and Roth (Bansal & Roth, 2000) states that it's mainly due to three reasons: competitiveness, legislation, and ecological responsibility.
The main problem that managers usually have when it comes to implement sustainable strategies is to translate them into actions because they don't know how sustainability performances can both affect and influence corporate profitability and the business.

The main reason is due to the fact that sustainable actions are more used to be linked to long-term goals, high level of uncertainty and they're not always easy to quantify while companies want quantitative and certain results. So, how can sustainability influence and be better integrated into day-to-day operational decisions?

Epstein and Roy (Epstein & Roy, 2001) tried to present a framework that could change the way companies look at business (Fig.7).

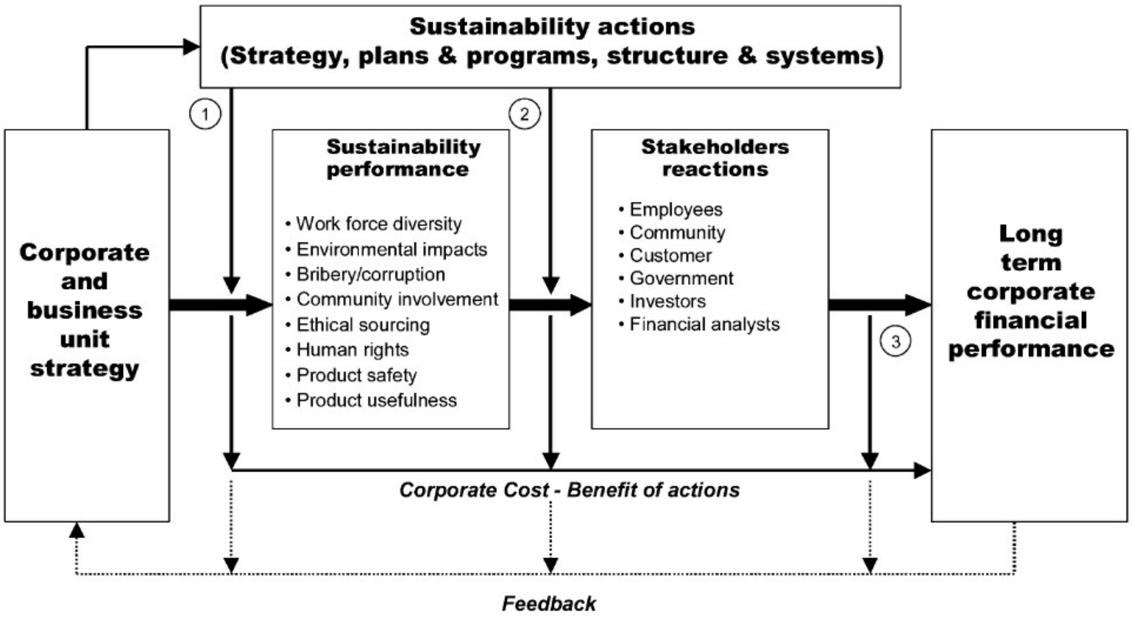

Fig.7 Drivers of sustainability and financial performance. Source: Epstein & Roy (2001)

It's organized into five major components:

1) Corporate and Business unit strategy;
2) Sustainability actions;
3) Sustainability performance;
4) Stakeholders' reactions;
5) Long-term corporate financial performance.

The first focus the company has to have is to define its corporate and business unit strategy, which is basically from where everything begins. Once there's a strategy, sustainable actions can be implemented, defining their strategy, plans and programs, structure and last, but not least, the measurement of each performance. After that, the company has to focus on the sustainability performance it has defined and that will directly reflect on its stakeholders, and in the end, everything will converge into long-term financial performance.

This is an endless circle as from every part of the framework there are always possible feedbacks that can determine the redefinition of the initial strategy. These feedbacks don't necessarily rely on financial performance, and that is the reason why they can come from every part of the model. Companies that rely solely on financial results won't have the relevant information to accurately capture the total picture since they can't explain certain behaviors that could affect future performance goals (Epstein & Roy, 2001).

Strictly linked to that, another study conducted by Epstein and Roy (Epstein & Roy, 2003) affirms that companies can be divided into four levels, according to which extent sustainability is taken into account. Hence, level 1 companies tend just to give descriptive information on their sustainable actions, not having any link with financial performance. Level 2 is similar to level 1, giving instead quantitative information.

A big leap is then done by level 3 companies, who provide monetized information behind sustainable actions, partially linked to financial performance whereas level 4 provides the same as level 3 but fully linked to them.

It may seem that there is no such a big difference between the last two levels when, instead, it can be explained as follows: level 3 companies give, for example, monetized information on how much a company has invested aiming to reduce a certain type of emissions while level 4 tend more to provide reports that for each "sustainable" cost associates its related benefit (Tab.2).

	Information	Costs description	Related benefits
Level 1	Descriptive	No	No
Level 2	Quantitative	No	No
Level 3	Monetized	Yes	No
Level 4	Monetized	Yes	Yes

Tab.2 Sustainable levels and details

2.2.2 ELC business's point of view

The sustainable purpose at ELC is to reduce the $CO2_e$* emissions generated by transports from the origins – mostly based in Indonesia, Vietnam and China (Appendix 5) – for both DC's and DRS's flows, trying to propose alternatives either for routes and means of transport or for alternative fuels.

To see whether the Inbound vision and, more generally, the global vision at Nike ELC matches what found from the literature researches, an interview has been performed with the Inbound Transportation manager, Karen Thoonen.

The reason why Nike wants to invest in sustainability is a mix of both personal beliefs and external pressures because it's important to look at Nike's position (Thoonen, Inbound Business View, 2019). Indeed, the brand is really popular, and partners are always willing to work with the company; hence, if the company moves to greener solutions to increase its image, complying also with the legislation, they will be pushed to follow it.

Nike has already made some progresses in these past years, activating the sea-air transports (hybrid between a vessel, from A to B, and a plane, from B to C, to reduce air freight emissions), running a pilot study to see which the benefits of using rails to perform transports from the Far-East to Europe could be and starting the air freight banning.

The reason why the company took these actions was not just because they wanted to be greener. In fact, air freights reduction reflects not only in a reduction in $CO2_e$ emissions but also in better costs' efficiency (Appendix 6), and this is how Nike has started to develop, always taking duo decisions: from one side they look at cost and service while on the other one the main focus is sustainability, a side that was just a dead-end since few years ago.

An example of how Nike is now starting to consider sustainability when business decisions have to be taken can be represented by the Arctic Pledge.

This pledge foresees (Nike, 2019), for the companies who want to stick to it, to avoid the navigation from the arctic route even though this will negatively reflect on lead time and cost performance. Indeed, studies from Lee and Song (Lee & Song, 2014) have estimated that going from Asia to North Europe via the arctic route would save around 5000 nautical miles (~9200 Km) compared to the same journey done passing through the Suez Canal. Nike has initiated this pledge since climate change started causing the decrease of sea ice. It is known that the temperatures in the Arctic rise faster than elsewhere. Hence, the company found an agreement with three of its LSP's to not take that route when its containers have to be transported, consequently sacrificing two of its main drivers, cost and service, for an environmental purpose.

* $CO2_e$ is used to compare the contribution of two GHGs (the benchmark is always CO2) to global warming. Each GHG has its own GWP that is valid for a time frame (~100 years). As an example, the GWP of nitrous oxide is 298. As a result, the emission of 1 ton of this gas impacts global warming as the emission of 298 tons of CO2.

As Epstein and Roy (Epstein & Roy, 2001) affirmed, the main difficulty for the managers to implement sustainable strategies is that they diverge from what the business wants.

At Nike, instead, the culture is the main driver that makes sustainability be part of day-to-day operations, even if the outcomes will be seen in the long run. In fact, everyone goes and looks in the same direction; sustainability is getting part of their DNA.

Hence, if a new idea wants to be implemented, it can be possible to make analyses based on that, and even if the wished results don't arise, the sustainable decision is not compromised. It will be analyzed deeply, trying to find good reasons to implement that solution.

The reason why Nike does that is because the company wants to be the frontrunner on sustainability, being always ready to invest or pay premiums, even losing in the short-run (e.g. investment on LogEC software), to gain a competitive advantage in the future.

2.3 Research questions

To be able to focus the research on the main topic, avoiding writing an "all-about" paper, two research questions have been proposed from the co-supervisor of the project, truly believing that they can provide an answer to the ultimate goal to see whether sustainability can represent a key driver for the business process within the Inbound Team at Nike ELC, contributing to the $CO2_e$ emissions reduction goal:

1) **What could be the impact on both $CO2_e$ emissions and the company's business if the allocation of the containers among all the LSP's were to be allocated differently form how it has been done until now**?

The main idea of answering this question is to test whether, taking into account the $CO2_e$ emissions produced by each carrier, the expected volume for the FY20 could have been split differently.

Indeed, for now, when the analysts have to divide the volume produced from the origins and that will be distributed in the EMEA regions, they just look at how much it costs, how can the risk be spread and how much time a carrier spends to ship them, not caring about the emissions.

Hence, the idea is firstly, throughout a desk research, to understand how Nike ELC's flow is organized and how the volume is split per carrier. Secondly, a deeper analysis will be performed with the help of LogEC. The analyses will be then carried out running different simulations with the final aim to get a trade-off between the three drivers, costs, service, and emissions, to see whether a new allocation would have resulted in a better outcome or not.

2) **Can a carbon neutral product represent a feasible solution for Nike to come as close as possible to the FY20 $CO2_e$ reduction target, taking also a look into the future sustainable goals?**

Nike has found an agreement with one of its LSP's for buying a selected small number of TEU containers that will be transported within vessels powered by biofuel energy. This solution is estimated to reduce the CO2 impact by 85% compared to fossil fuels.
Since the pilots are still ongoing, and the fuel has not been implemented yet in Nike's vessels, the idea of this research question is to make a theoretical analysis on alternative solutions – among which the alternative fuels - to see whether they can affect the sustainable performances of the company, eventually being implemented in a large-scale scope.

The logic and purpose of both the research questions are to push sustainability inside the Inbound process, both verifying what would be the business outcome of the company and the impact on $CO2_e$ reduction.
More specifically, the first research question is aimed to give numbers on how much a volume reallocation process could affect the carbon footprint while the purpose of the second one is to find alternatives that, together with the benefits that might come from the first, could bring the company to beat the settled targets.

2.4 Risks and limitations

Behind each project, there are risks and limitations. In this case, they can be summarized as follows:

1) Nike ELC's flow is enormous as it counts more than 700 factories within 40 origins where the products are manufactured. Therefore, track it in a highly detailed way could be difficult as there could always be changes or unexpected events that can't be directly taken into account/fixed in LogEC;
2) Some assumptions have been made when the software was implemented (Appendix 7). Hence, the results could be affected by them since the data accuracy of the software is not necessarily 100% precise and could be based on average values.

3) The absence of experts of the software could limit the research since some questions can't be either answered in detail or answered at all;
4) The research is made out of tests. Since the flow can't be eventually changed in the short-run to test whether the results are really good or not, they will be based on simulations run within the software, risking missing some factors that could affect the real performances.
5) The subject of the project is almost new to the company in the way it's tackled. Hence, the results are confined to the proposed research questions, and they can just be used as guidelines for further sustainable studies.

3 Inbound Transportation

Before the pure analyses can be shown, it's of key importance to explain how Inbound Transportation is conceived, how it works, what is the data history behind it about the amount of volume shipped and its environmental impact, how is it going to evolve in the next years, which kind of means of transport are used to deliver the products, and what are the expectations for it for the future from Nike.

Therefore, the following chapter aims to provide this information to then guide the reader through the outcome got from the experimental phase.

3.1 Inbound Transportation flows

The Inbound Transportation team is responsible for delivering the goods from upstream of the supply chain, from the factories, based on the different flows which are listed below:

- Nike DC Flow
- Direct-Direct
- Decon UK Flow
- Decon ROE Flow

$\left.\begin{array}{l}\text{Direct-Direct}\\ \text{Decon UK Flow}\\ \text{Decon ROE Flow}\end{array}\right\}$ **Direct Ship Accounts (DRS)**

Within the team, the responsibilities are divided according to two main pillars: DC and DRS flow. The first one takes care of all the products that arrive at the distribution centers, in Laakdal, while the second one focuses on all the goods arriving either at the deconsolidation centers or to the customers.

Below (Fig.8), the four different flows along with the allocated amount of transportation are depicted. Nike ELC flows deliver 350 M units annually, split as follows:

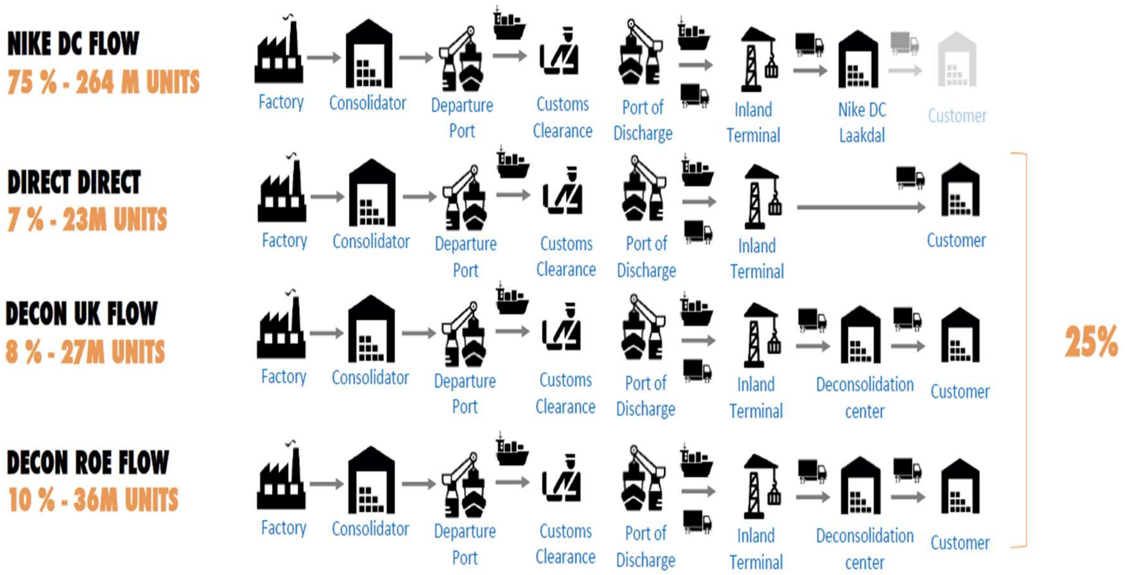

Fig.8 Nike ELC Inbound Flows. Source: Introduction to Inbound Transportation

As can be noticed, the main volume is concentrated into the DC flow, as most of the products arrive in Laakdal to being then delivered to the customer. However, future expectations foresee a reversal of the actual situation, with the DRS flow that will become more and more important increasing the number of units shipped per year (Nike, DRS E2E Journey, 2019).

Further details about the future goals and expectations for Inbound Transportation will be discussed in the next paragraphs.

For the flows depicted in figure 8, Nike is using different transport modes to deliver to the final customer. More specifically, Nike is now using: Trucks (TR), Vessels (VL). Sea Air (SE) and Air Freight (AF).

Although lately some studies and analyses have been conducted to see whether Rail transport can be added to Nike’s transportation portfolio, it won’t be taken into consideration since it’s still under investigation and not fully implemented yet.

On a flow level, every product is initially scheduled to go via deep-sea vessel, meaning that nothing is initially being scheduled to go via air. However, there are situations where airfreight transportation is needed because deep-sea can take up too much time (Appendix 8). These goods either have a higher priority on the others, meaning that they got either an “express” request or are volumes that do need to be at their final destination faster than the deep-sea mode offers, or a mistake has been previously made on the transportation planning. In fact, products that are deprioritized are not necessarily shipped via sea. There is an algorithm for those products that decides whether using air transportation is worth or not, and it is managed by the planning team from GFP (Papoutsis, Shipments planning, 2019). What can happen, then, is that the products arrive at the destination before the expected arrival date. This leads to additional work and costs since a storage place and the following transportation needs to be planned.

Data from the FY2018 and FY2019 (Tab.3) shows that on average VL transports contributed to 90% of the total amount of units shipped, AF for the 3.5% and TR for the 6.5% (Nike, FY20 EMEA Inbound and Outbound, 2019). A slight percentage is addressed to the Sea Air mode since it hasn't been a long time since it was implemented.

EMEA Inbound

Inbound

				VL	AF	TR	SE	
GEO	Fiscal Year	Quarter	Month	Ocean Units	Air Units	Truck Units	Sea/Air Units	Total Units
EMEA	FY2018	FQ01	June	26,530,290	2,012,415	2,014,499	-	30,557,204
EMEA	FY2018	FQ01	July	24,017,345	1,276,847	1,285,950	-	26,580,142
EMEA	FY2018	FQ01	August	29,195,632	2,086,703	2,898,532	-	34,180,867
EMEA	FY2018	FQ02	September	24,583,804	2,016,524	1,078,316	-	27,678,644
EMEA	FY2018	FQ02	October	19,101,183	1,682,580	1,010,192	-	21,793,955
EMEA	FY2018	FQ02	November	21,939,994	1,244,174	1,205,065	-	24,389,233
EMEA	FY2018	FQ03	December	22,290,395	1,198,631	1,503,916	-	24,992,942
EMEA	FY2018	FQ03	January	31,701,690	1,326,354	1,408,914	-	34,436,958
EMEA	FY2018	FQ03	February	26,624,970	568,819	1,731,175	-	28,924,964
EMEA	FY2018	FQ04	March	26,517,872	964,814	2,209,161	-	29,691,847
EMEA	FY2018	FQ04	April	25,107,225	939,510	2,577,268	-	28,624,003
EMEA	FY2018	FQ04	May	30,329,263	1,006,171	2,480,717	-	33,816,151
			Average units shipped	89.09%	4.72%	6.19%	0.00%	
EMEA	FY2019	FQ01	June	29,125,637	875,292	2,767,267	-	32,768,196
EMEA	FY2019	FQ01	July	32,642,468	1,162,303	2,177,523	-	35,982,294
EMEA	FY2019	FQ01	August	29,437,201	1,043,514	2,225,225	-	32,705,940
EMEA	FY2019	FQ02	September	25,808,879	825,475	1,496,960	-	28,131,314
EMEA	FY2019	FQ02	October	25,866,178	1,194,449	1,816,711	-	28,877,338
EMEA	FY2019	FQ02	November	22,839,500	1,046,889	1,377,355	-	25,263,744
EMEA	FY2019	FQ03	December	23,660,796	923,696	2,287,890	1,888	26,874,270
EMEA	FY2019	FQ03	January	31,226,440	1,380,894	2,808,415	-	35,415,749
EMEA	FY2019	FQ03	February	27,615,653	502,079	1,947,415	-	30,065,147
EMEA	FY2019	FQ04	March	26,990,112	1,014,604	2,594,117	37,190	30,636,023
EMEA	FY2019	FQ04	April	28,690,744	1,961,407	2,608,928	195,090	33,456,169
EMEA	FY2019	FQ04	May	32,348,852	912,288	1,732,931	-	34,994,071
			Average units shipped	89.63%	3.42%	6.89%	0.06%	

Tab.3 Nike Inbound Data FY2018-FY2019 per mode of transport. Source: Nike Inbound Data

All the previously-depicted flows have some similarities; indeed, the upstream process from the "Factory" to the "Inland Terminal" follows the same principles no matter which flow is considered.

Firstly, each product flows from the factories, from different countries all over the world to a consolidation center whose function is to aggregate into containers all the Nike products that will follow a precise route. Usually, the consolidation center is situated nearby the departure port from which the goods will leave. Once the vessel has performed the main transportation leg – port to port –, it reaches the discharging port, which for EMEA is always represented by the ports of Antwerp and Rotterdam for the "Nike DC Flow", "Direct-Direct" and "Decon ROE Flow", while by Southampton, London Gateway and Felixstowe in the UK for the "Decon UK Flow". The next step foresees the "Custom Clearance" phase before the products can be unloaded to then being transported, either via trucks or barges, to the Inland Terminal. From there on, each flow has its own characteristics.

As previously mentioned, the biggest flow in terms of volume for Nike ELC is the "Nike DC Flow". In this flow, the containers are shipped directly to the distribution centers in Belgium where the goods are stored and then delivered to different customers. DC's serve retail digital orders of smaller customers. The Inbound responsibility ends once the product hits the DC's, meaning that its final customer is the campus in Laakdal. For the European flow, all the containers have the prerequisites of passing through the Inland Terminal before being delivered (Wong, 2019).

Although most of the units that are shipped pass via the DC's, the DRS flow is assuming higher priority year after year. At its core, the "Direct-Direct" flow can be found, whose purpose is to deliver directly from the factories to the customer, without the need for extra handling. For the past fiscal year, the flow contributed to 23 M units shipped.

Differently from it but always under the DRS ownership, there are the two Decon flows: UK and ROE.

The "Decon ROE Flow" serves smaller wholesaler customers or big Nike accounts. It's similar to the "Direct-Direct", with the exception that not fully loaded containers are shipped, and they have to go through the deconsolidation center. There, the shipments are gathered and transported to different locations in the EMEA regions.

The "Decon UE Flow" slightly differs from the ROE flow as it's not prerequired for the containers to go through the Inland Terminal. They can be directly picked up from the port by the customers. For the rest of the containers that are addressed to smaller shipments, the deconsolidation process needs to take place before delivering the products to the final customer.

3.2 Historical data analysis

A big contribution to the company's fame from the upstream of the supply chain is given by the Inbound Transportation team, and it is, therefore, appropriate to see how Nike ELC has performed in the past years, looking at how the products have been transported and which trends they have followed.

In addition, since the research's main objective aims to investigate how transportation's sustainability performances can improve, it's crucial to see how they've evolved so far and what caused that to happen.

3.2.1 Volumes and emissions: data and trends

A qualitative and quantitative analysis of the data of the last 24 months was carried out to support and direct the research in understanding the evolution of the amount of products transported by the different means, consequently bringing to light what is the impact of each of them from a sustainable point of view.

The starting point of this analysis was therefore focused on the collection of such data for both the FY2018 and FY2019, examining the volume of units transported monthly and finally collecting an aggregate of data on an annual basis, looking at their evolution and trying to understand the possible future trends (Fig.9).

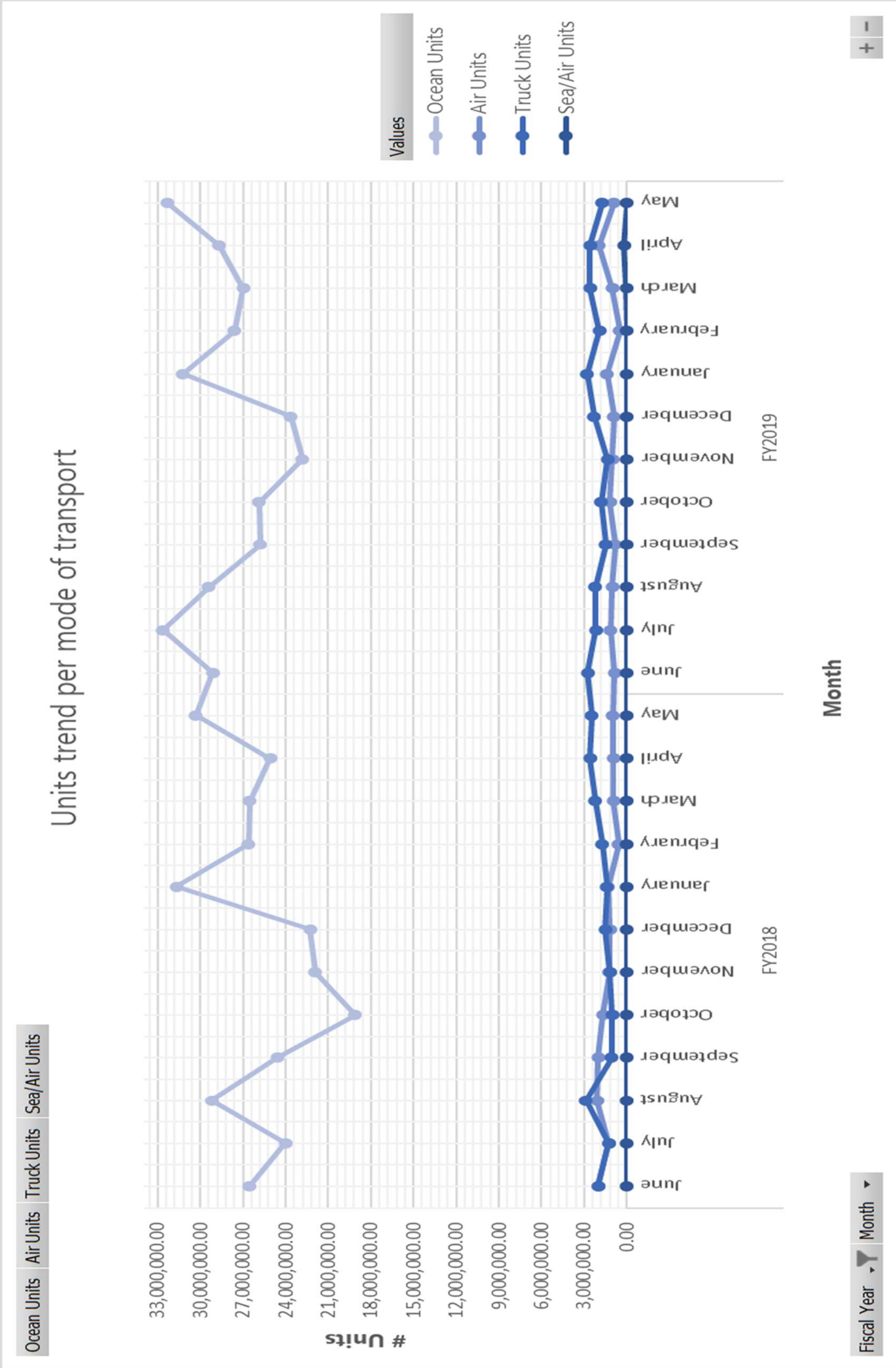

Fig.9 Units trend per mode of transport, FY2018-FY2019. Source: Nike Inbound Data

As can be seen from figure 9, the evolution of the volumes transported has always seen and still sees a main means of transport used such as ships, assisted in the background by aircraft and trucks, with the recent addition of the sea-air methodology. It usually involves sea transport to the port of Dubai/Jebel Ali, resulting then in the use of air transport to reach Brussels.

The maritime transport is usually preferred to other modes for a variety of reasons among which:

1) The ability to carry a much greater amount of containers than other types of vehicles. Indeed, a ship is capable of carrying up to 9000 FEUs, corresponding to about 608 000 CBMs*, while the second-largest means of the aforementioned, the aircraft, has a maximum capacity of 752 CBMs** (AirBridgeCargo, 2019);
2) Cost-wise, ships are the cheapest solution for long distances compared to Sea-Air and Air Freight (Appendix 6);
3) Similar to what written before, ships are also the most environmentally friendly means of transport (Appendix 6).

Once the qualitative analysis was completed, it was appropriate to see in numbers what were the Nike ELC trends in terms of freight transport. Table 4 has been therefore realized to support the previous analysis.

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* For the conversion from FEU to CBM data from Wikipedia was referred to, in which a FEU corresponds to 67.6 m^3 (DSV, 2019). This data was subsequently approved by the manager.

** The CBMs capacity of the cargo planes refers to the most commonly used freighter by one of Nike's providers. 752 CBMs are divided in:

- Main Deck Volume = 607.7 m^3
- Lower Hold Volume = 130.3 m^3
- Bulk = 14 m^3

		June	July	August	September	October	November	December	January	February	March	April	May	Total Units shipped
Ocean Units	# Units (FY2018)	26,530,290	24,017,345	29,195,632	24,583,804	19,101,183	21,939,994	22,290,395	31,701,690	26,624,970	26,517,872	25,107,225	30,329,263	**307,939,663**
	%	87%	90%	85%	89%	88%	90%	89%	92%	92%	89%	88%	90%	89%
	# Units (FY2019)	29,125,637	32,642,468	29,437,201	25,808,879	25,866,178	22,839,500	23,660,796	31,226,440	27,615,653	26,990,112	28,690,744	32,348,852	**336,252,460**
	%	89%	91%	90%	92%	90%	90%	88%	88%	92%	88%	86%	92%	90%
Air Units	# Units (FY2018)	2,012,415	1,276,847	2,086,703	2,016,524	1,682,580	1,244,174	1,198,631	1,326,354	568,819	964,814	939,510	1,006,171	**16,323,542**
	%	7%	5%	6%	7%	8%	5%	5%	4%	2%	3%	3%	3%	5%
	# Units (FY2019)	875,292	1,162,303	1,043,514	825,475	1,194,449	1,046,889	923,696	1,380,894	502,079	1,014,604	1,961,407	912,288	**12,842,890**
	%	3%	3%	3%	3%	4%	4%	3%	4%	2%	3%	6%	3%	3%
Truck Units	# Units (FY2018)	2,014,499	1,285,950	2,898,532	1,078,316	1,010,192	1,205,065	1,503,916	1,408,914	1,731,175	2,209,161	2,577,268	2,480,717	**21,403,705**
	%	7%	5%	8%	4%	5%	5%	6%	4%	6%	7%	9%	7%	6%
	# Units (FY2019)	2,767,267	2,177,523	2,225,225	1,496,960	1,816,711	1,377,355	2,287,890	2,808,415	1,947,415	2,594,117	2,608,928	1,732,931	**25,840,737**
	%	8%	6%	7%	5%	6%	5%	9%	8%	6%	8%	8%	5%	7%
Sea/Air Units	# Units (FY2018)	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
	# Units (FY2019)	0	0	0	0	0	0	1,888	0	0	37,190	195,090	0	**234,168**
	%	0%	0%	0%	0%	0%	0%	0.01%	0%	0%	0.12%	1%	0%	0.06%

Tab.4 # Units and % per mode of transport, FY2018-FY2019. Source: Nike Inbound Data

The use of ships over the last two years has never fallen below 85%, reaching an annual average of 89% of the total volumes transported in FY2018, with a slight increase of 1% in the following year, contributing to the transport of ~340 M units out of a total of 375 M.

As for the use of trucks, on the other hand, although limited to a small portion of the flow, generally either from the unloading port onwards or from the European origins given the great distances that it should otherwise cover to move from one continent to another for the main leg, we see a 1% increase in FY2019.

The opposite situation can be depicted for air transport, which sees a 2% decrease in the number of products transported, with the highest percentage on a monthly basis of 8% recorded in FY2018 in October. The reason is mainly sustainable-related and lies in Nike's strategy for its future. In fact, as already mentioned in the previous chapters, the company's commitment to environmental sustainability has become stronger and stronger over the years and, from a freight transport point of view, aims to reduce $CO2_e$ emissions by 20% in FY2020 for the entire Transportation department.

As a result, there was the beginning of the AF banning in FY2019, trying to reduce its use as much as possible, partially sacrificing a driver such as lead time in favor of both cost and emissions. In fact, it is possible to note from table 4 that the monthly percentage utilization of the AF was only once at 6%, then stabilizing to about 3% for the rest of the year. Although in a lighter way, the start of AF banning coincided with the activation of the sea-air transport mode and the study for the implementation of rail transport.

Figure 10 helps to understand how the trends, in terms of $CO2_e$, have evolved as a result of the actions taken.

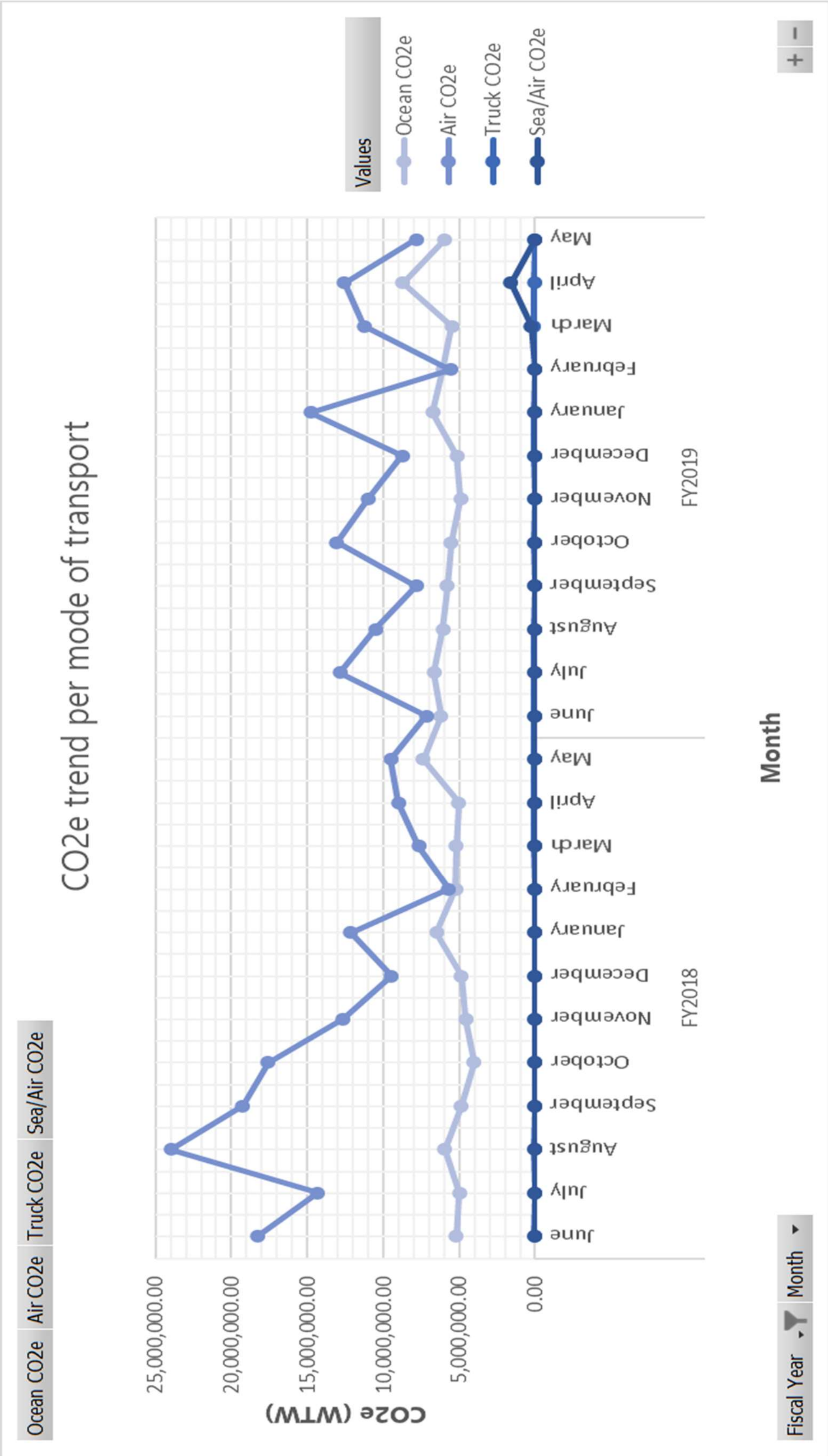


Fig.10 $CO2_e$ trend per mode of transport, FY2018-FY2019. Source: Nike Inbound Data

As can be seen, air transport is the most polluting mode, considered as 25 times more carbon-intensive than ocean shipping (Nike, Carbon Energy, 2018), and it arrives up to 50 times more if $CO2_e$ emissions are considered. Its banning, however, has led to a significant decrease in emissions, going from an average of 13.5 M kg per month, for a total of 160 M kg in FY2018 to an average of 10 M kg in FY2019, for a total of 125 M kg.

As a result, the emissions of maritime transport, trucks, and sea-air have increased due to the higher volume transported.

Table 5, however, shows that a 23% decrease in AF emissions is matched by a 15% increase for ocean freights and 56% for trucks, whose environmental impact is still lower: a decrease of 36 M kg of $CO2_e$ due to a lower use of AF corresponded to an increase of 10 M kg for the use of other means.

	CO2e (WTW) Kg		
	FY2018	FY2019	Δ
Ocean	63,900,646.30	73,453,464.00	9,552,818
Air	159,640,690.34	123,306,255.21	**-36,334,435**
Truck	423,083.22	662,274.85	239,192
Sea-Air	0.00	1,868,577.74	1,868,578

Tab.5 $\Delta CO2_e$ per mode of transport, FY2018-FY2019. Source: Nike Inbound Data

The result unearthed from these analyses has allowed to direct the study and research on ways and alternatives that can impact $CO2_e$ emissions caused by the main mode of transport used by Nike, namely maritime transport. Among the reasons for this choice:

1) Ocean transportation can be impacted on an environmental level both by organizational (e.g. allocation volumes on different carriers, stipulation of new alliances) and innovative changes (e.g. investment in alternative fuels);
2) It accounts for 90% of the volume transported each year;
3) It might have been interesting to analyze more in-depth the potential offered by the sea-air mode. However, since it has recently been implemented, the lack of data mainly due to the low volume of products transported would not have led to significant analyses;
4) An analysis of air transport could have been done because of the amount of emissions it causes. However, the small number of products transported has influenced the choice of wanting to focus on shipping. Furthermore, since the analyses were carried out through the LogEC software, and there are no

significative differences among the planes the providers use, their database is set by default (Nike uses both cargo and passenger planes, which are convenient as the volumes are usually not high, and they're all equally set for each provider).

3.3 Future goals

To maintain its leadership as a sports brand, Nike doesn't only act in the present but also gives an eye to the future to the possible opportunities, innovations, and alliances that could increase its prestige and fame. More specifically, thinking in terms of sustainability, it has been analyzed by Bansal and Roth (Bansal & Roth, 2000) how this sector is prevalently based on long-term results with a high level of risk and not always easy to quantify.
It is, therefore, necessary to analyze the way in which Nike has approached the definition of its sustainability goals and targets in these years, in the first instance, to then focus on those for the future, with an analysis of the levers on which the company wants to lean on to achieve them.
Nike's working and development plans are usually organized in five years. In this case, the two reference five-year terms are those of 2015-2020 – present - and 2020-2025 - future.

3.3.1 FY2015-FY2020

From a transport perspective, following external pressures on climate change and the analysis of the corporate carbon budget trend (Nike, 2019), the company reorganized its strategy. This is why the main target set for the five-year period 2015-2020, which is also linked to the Paris Agreement targets, resulted in a 20% reduction in $CO2_e$ emissions.
Of the levers adopted by Nike to pursue this goal, some of them have already been mentioned in the previous paragraphs, such as the beginning and continuation of air freight banning, the activation of the sea-air transport methodology, the realization of pilot studies to look for alternative means of transport (e.g. Rail) and market research for the implementation, in accordance with LSP's, of alternative fuels to power Nike's transportation.
Among all the possible levers, the one that attracts the most interest and that could impact the "modus operandi" of Inbound transportation for years to come, results in the re-evaluation and optimization of the allocation of the annual volume transported through LSP's from origins to the discharging ports. The impacts of this lever have been the subject of study and research of this work and will, therefore, be presented in the following chapter.

3.3.2 FY2020-FY2025

As for mid/long-term goals, however, Nike's ambitions are high on its impact on climate change. The main objective set last November is to achieve an absolute $CO2_e$ emissions growth of -4% by the end of FY2025 (Nike, Sustainability Alignment, 2019). Its meaning can be explained as follows. This growth is directly linked to that of the business; as a result, a hypothetical growth in the business, in terms of production volumes, of 30% from FY2019 to FY2025 would probably be reflected in a corresponding equal growth in $CO2_e$ emissions due to the more intense rate of shipment of goods. The real consequence for Nike is that of wanting to take actions that can lead to a 34% reduction in emissions (30% + 4%) to neutralize its impact (Papoutsis, Sustainable Targets for the Future, 2019).

The pursuit of this objective is based on three key aspects:

1) **Implementing alternative fuels in ocean shipping**. The most promising and accessible alternative fuel in the market is currently LNG. Recent data estimate that investments in LNG in 2019 have reached unprecedented altitudes of up to $50 billion (Slav, 2019). Among the main reasons for the attraction to this fuel is its high availability in the market (it is estimated that the abundance of LNG can persist for about 200 years, while that of oil reserves for about 50) (SLNG, 2019) and the significant impact it can have on reducing CO2 emissions (~30% less than other fossil fuels).

   In addition to this type of investment, Nike wants to explore as many alternatives as possible to expand its "sustainable portfolio". It is, for this reason, that pilot studies are currently carried out in partnership with an LSP, with the aim of being able to take advantage of a transport powered by biofuel that can lead to a reduction in CO2 emissions, according to estimates, of about 85% (Maersk, 2019);
2) **Routing**. Continuing air freight banning is essential in impacting the environment as little as possible. Recent data estimate a percentage of air freight usage by Nike ELC, from 2019 to date, of about 3% (Nike, FY20 EMEA Inbound and Outbound, 2019). The objective for the above five-year period is to reduce this percentage to 1.8%, which could be completed mainly as a result of a more accurate planning execution by the GFP team (Papoutsis, Shipments planning, 2019);
3) **Others**. Besides the major changes in the flows' organization and means of transport, even small improvements can contribute to achieving this goal.

Among these, for example, greater visibility in tracking and tracing. One possible solution would be to monitor via GPS the actual routes performed by trucks. Such a solution would provide live monitoring of what is the routing of trucks in such a way that the company would always be ready and responsive to act in the case of unexpected events (e.g. truck changing road, the driver stopped more than expected at some point).

To further encourage the promotion of these levers, a graph showing the evolution of $CO2_e$ emissions, if Nike were to take this route, has been realized. It has then been compared to the opposite situation, called "Do nothing scenario" (Fig. 11). The construction of the latter was achieved assuming a steady annual growth of 6.7%, according to the GFP team's forecasts (Papoutsis, Shipments planning, 2019).

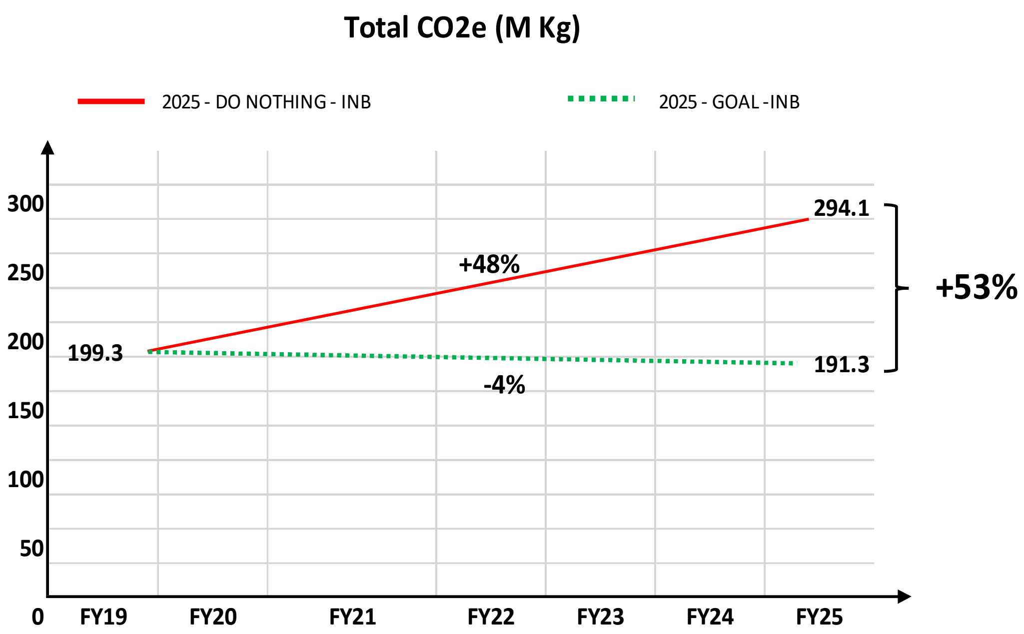


Fig.11 Do Nothing vs Goal Scenarios. Source: Nike Inbound Data, LogEC

As can be seen from figure 11, neglecting the environmental impact of freight transport would lead to a 48% increase in emissions, compared to the current situation where emissions amount to a total of 199.3 M kg (Nike, FY20 EMEA Inbound and Outbound, 2019). Acting, instead, would lead to a reduction of ~4%, which would reflect the company's stated goal. The gap between the two situations is wide, at 53%.

In order to meet the targets set for FY2025, the annual percentage of volume's allocation is foreseen to change as follows (Fig.12):

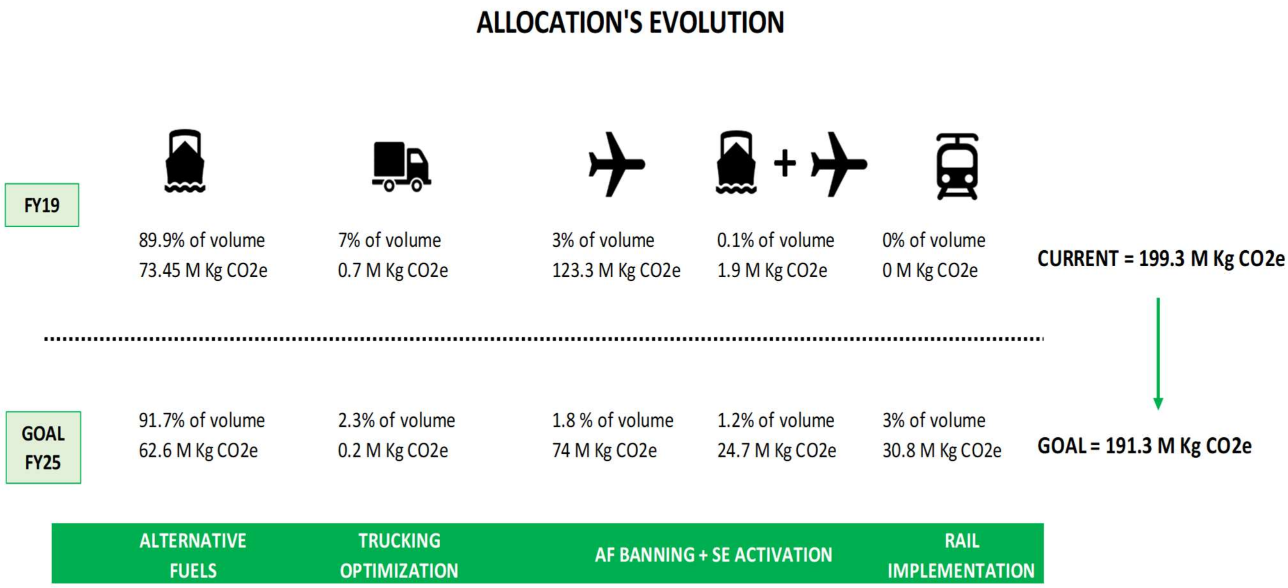


Fig.12 New Inbound landscape per mode of transport and initiatives to pursue the FY2025 goal. Source: Sustainability Alignment

The resulting amount of $CO2_e$ for FY2025 was calculated using the impact factors of table 6. Everything has been normalized around the AF emission factor, which was consequently set equal to 1.

As can be noticed, the amount of $CO2_e$ emissions for vessels has not only been based on the impact factor. In fact, those numbers have also been influenced both by the estimates about the consequences that the implementation of alternative fuels would have on their emissions and by the target Nike wants to reach by the end of the FY2025. (Papoutsis, Sustainable Targets for the Future, 2019).

IMPACT FACTOR	AF	SE	RAIL	TR	VL
	1	0.5	0.25	0.002	0.02

Tab.6 Impact factors. Source: LogEC

4 Operating model and scenarios' evaluation

The previous chapter helped to understand how transport flows are organized for Nike EMEA, what means are normally used, in which percentage and how it aims to evolve in the future.

The key point of the research now lies in a specific objective: the evaluation and optimization of the sustainable performance of Inbound transportation for the main means of transport it uses, the ships. This assessment was not carried out with the sole objective of wanting to minimize $CO2_e$ emissions but rather framed in a study of a three-variable problem such as costs, lead time and, indeed, emissions, to find a solution that can optimize the latter while obtaining reasoning values for the other two.

The main reason for this choice is to integrate sustainability, like the other two variables, into a business decision process such as the one that the team has to go through every year when the production volume from the different origins has to be split between the various LSP's.

The aim of these analyses is to see whether and how the volume allocation between the various providers could have been organized differently, thus providing a representation of the current situation – called "AS-IS" – in order to evolve into an optimal situation – called "TO-BE". The ultimate goal is to produce an analytical and justified answer to the first research question of this paper.

4.1 Analyses structure

The evaluation and consequent optimization of the "AS-IS" scenario was preceded by a first placement of the same in a three-dimensional space, which vertices were made up of the three mother variables of these analyses (Fig.13):

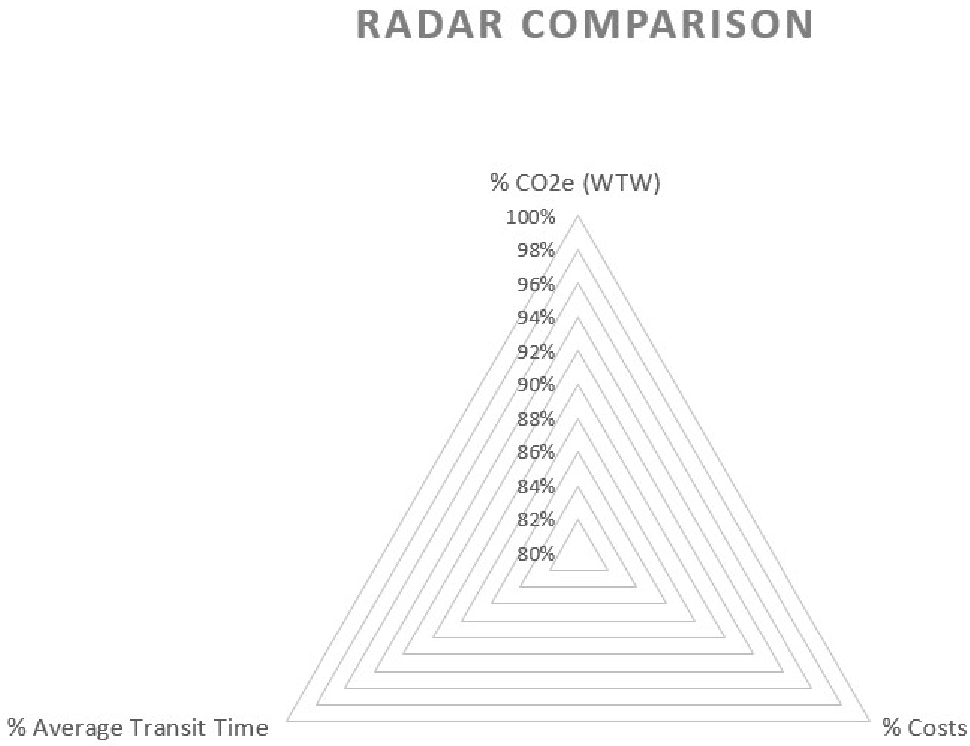


Fig.13 Outcome template

1) **Costs**, intended as price per container, previously negotiated with the various providers, to be paid for each lane. The final graph contains the sum of all the costs charged for a given scenario, calculated as the summation of the product of the volume allocated to each provider for its respective cost per container;
2) **Average Lead Time**, intended as the average scheduled transit time for each provider, from the various origins to the discharging port;
3) **$CO2_e$ (WTW) emissions**, intended as kg of $CO2_e$ (WTW) emitted depending on the port-to-port distance and emission factor of each provider. In fact, because the analyses were carried out with the help of the LogEC software, it required the loading of the emission values for each provider. Further details will be given during the scenarios' analyses.

As can be noticed from figure 13, the data shown on the graph are expressed in percentages. In fact, the main idea of these analyses was born with the intention of referring the "AS-IS" situation to a benchmark. This benchmark, in this case, is represented by the implementation of three preliminary scenarios, aimed at stressing to the maximum, one at a time, the three variables in order to obtain, for each of them, the best possible result for a given variable. The three preliminary scenarios are:

1) **Cost-saving**. This scenario was achieved by allocating the volume according to the cheapest solution for each lane;
2) **Time-saving**. Here the goal was to minimize the total average transit time;
3) **Eco-friendly**. Consistently with the previous ones, the breakdown was made by allocating the volume to the least polluting providers.

Since each of the three scenarios maximizes a single variable, the results obtained for each of them represent the best outcome in terms of costs, lead time and emissions, respectively, and will be represented in the graph with the highest percentage, which is 100%.

As a result, the "Cost-saving" scenario will have 100% in terms of cost efficiency, the "Time saving" scenario will have 100% in terms of time efficiency, and the "Eco-friendly" one in terms of the lowest emissions released* (Tab.7).

For a given variable, all the other scenarios will, therefore, be compared in terms of distance from the optimal solution: the lower their percentage, the greater their distance from the optimum.

		Scenario				
		Cost saving	Time saving	Eco-friendly	AS-IS	TO-BE
Variable	% CO2e (WTW)			100%		
	% Costs	100%				
	% Average Transit Time		100%			

Tab.7 Results table

4.1.1 LogEC setting

If excel spreadsheets based on data taken from the company's database were sufficient for the calculation of costs and transit time, the same was not possible for the calculation of the emissions. In order to obtain accurate values about this variable, it was necessary to set up the analysis support software, LogEC, and more specifically one of its tools, called LogEC Light.

In order to use this tool, the software needs to be powered by external data that allows it to process the flow of information to obtain the final results (Fig.14).

* The results obtained from the preliminary scenarios are very unlikely as they do not necessarily respect the constraints that the team must comply with in order to allocate the various volumes (Appendix 9). The main interest of this choice lies in the willingness to understand how a real situation differs from an ideal, eventually being able to lead to a possible change in the process structure, acting for instance on the constraints themselves as a result of the possible gains that might be obtained from scenarios seemingly improbable at first glance.

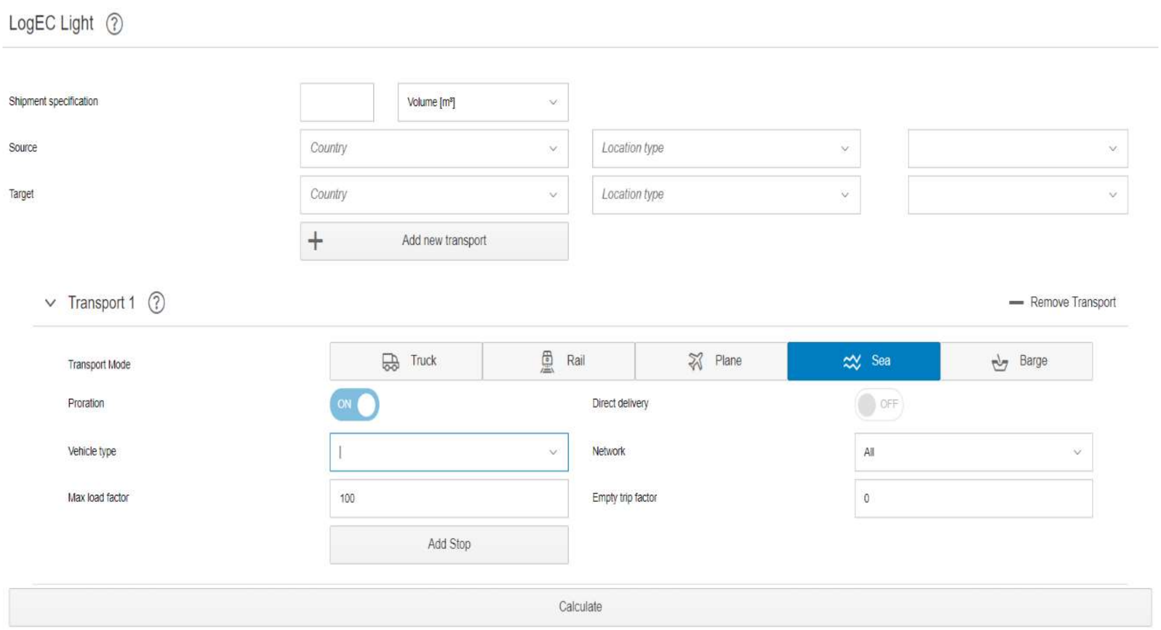


Fig.14 LogEC Light. Source: LogEC

As can be seen from figure 14, the data that the tool needs in order to be able to calculate the $CO2_e$ emissions are:

- **Shipment specification:** the weight, in terms of m^3, of the shipment;
- **Source:** the country from where the goods are shipped, the location type (e.g. airport, seaport, train station) and the code corresponding to the selected location;
- **Target:** it needs the exact same information as "Source", but for the destination point;
- **Vehicle type:** the vehicle used. In this case, the ship used and the corresponding provider (the software requires a previous loading and setting of the different vehicles).

Once this information is entered, the software provides the required results right after clicking on the "Calculate" button. Among the various outcomes, the two most important for these analyses are:

- $CO2_e$ (WTW) [kg]
- Distance [km]

This information will enable to monitor the emissions, being then able to get all the outcomes needed to evaluate each scenario.

4.2 Scenario 1: Cost-saving

The idea of developing such a scenario aims to find the cheapest solution in terms of cost per container and total cost. The main questions to which an answer was tried to be given were: "What if the allocation was based only on the cheapest price that the company can pay to a provider? What would be the percentage savings? And how would service and emissions be indirectly affected? Also, what constraints would be violated?"

The analysis tools for assessing this scenario, and most generally of all, were:

- An excel file for the ocean rates for the FY2020, containing the different negotiated prices per lane per provider, and the number of forecasted containers to be shipped per lane;
- An input sheet file containing all the planned transit time, per lane per provider;
- LogEC, fed with all the information needed to get the $CO2_e$ emissions, per lane per provider.

In this case, the allocation was made only using the price criterion. In case the same price was negotiated between two or more providers for a given lane, the containers have been split equally between them (Tab.8).

Origin City	Destination City	FY20 volume	FY20 final LSP 1	FY20 final LSP 2	FY20 final LSP 3	FY20 final LSP 4	FY20 final LSP 5	FY20 allocation LSP 1	FY20 allocation LSP 2	FY20 allocation LSP 3	FY20 allocation LSP 4	FY20 allocation LSP 5
Vietnam	Antwp/Rtrdm/Zbrg	11328	1220	**1145**	1220	1220	1210		1.00			
Indonesia	Antwp/Rtrdm/Zbrg	7224	1431	**1240**	1300	1290	1280		1.00			
China	Antwp/Rtrdm/Zbrg	2726	1140	1392	1145	1140	**1120**					1.00
China	Antwp/Rtrdm/Zbrg	2230	1130	1375	1850	1130	**1120**					1.00
Vietnam	UK Ports	2041	1220	**1195**	1240	1220	1210		1.00			
Vietnam	Antwp/Rtrdm/Zbrg	1363	1431	1260	**1200**	1260	1210			1.00		
Cambodia	Antwp/Rtrdm/Zbrg	1215	1911	**1590**	1895	1640	1620		1.00			
India	Antwp/Rtrdm/Zbrg	1076	**821**	1100		1014	1100	1.00				
Indonesia	UK Ports	1048	1431	1290	1325	1290	**1280**					1.00
Thailand	Antwp/Rtrdm/Zbrg	964	1515	**1081**	1325	1230	1220		1.00			
China	Antwp/Rtrdm/Zbrg	797	1170	1170	1225	1170	**1120**					1.00
China	Antwp/Rtrdm/Zbrg	766	1596	1474	**1290**	**1290**	**1290**			0.33	0.33	0.34
Pakistan	Antwp/Rtrdm/Zbrg	675	**636**	940	670	890	900	1.00				
Malaysia	Antwp/Rtrdm/Zbrg	402	1151	1309	**1125**	1170	1400			1.00		
China	UK Ports	324	1140	1342	1175	1140	**1120**					1.00
China	UK Ports	292	1130	1400	1875	1130	**1120**					1.00

Tab.8 Cost-saving allocation. Source: Flows LT – Cost-saving. Source: Nike Inbound Data

Based on the forecasts provided at the beginning of the fiscal year by the GFP team on the expected volume of containers to be shipped from the different origins, all the lanes have been divided into three levels:

1) **BIG** lanes, for those whose volume was forecasted to be ≥ 800 containers;

2) **MID** lanes, for those whose volume was forecasted to be ≥ 200 and < 800 containers:
3) **SMALL** lanes, for those whose volume was forecasted to be < 200 containers.

Table 8 represents a frame of the total allocation, which can, however, be consulted in Appendix 10.

Once the allocation was determined, a template common to each scenario has been created to be able to write down all the necessary information in order to extrapolate the results that were then fed into the radar graph (Tab.9).

Country	Country Code	Destination	Transit Time	LSP	Volume [# containers]	Volume [m3]	Cost/container	Cost/container (/1000)	Cost [$]	Distance [Km]	CO2e (WTW) [Kg]
Vietnam	VN	Antwp/Rtrdm	26	2	11328	765,773	1,145	1.15	$12,970,560.00	16738	23,543,286
Vietnam	VN	UK Ports	34	2	2041	137,972	1,195	1.20	$ 2,438,995.00	16642	4,217,565
Indonesia	ID	Antwp/Rtrdm	26	2	7224	488,342	1,240	1.24	$ 8,957,760.00	16677	14,959,333
Indonesia	ID	UK Ports	24	5	1048	70,845	1,280	1.28	$ 1,341,440.00	15909	2,218,156
China	CN	Antwp/Rtrdm	23	5	2726	184,278	1,120	1.12	$ 3,053,120.00	18569	6,791,654
China	CN	UK Ports	25	5	324	21,902	1,120	1.12	$ 362,880.00	18182	790,524
China	CN	Antwp/Rtrdm	28	5	2230	150,748	1,120	1.12	$ 2,497,600.00	19613	5,818,828
China	CN	UK Ports	30	5	292	19,739	1,120	1.12	$ 327,040.00	19528	758,617
Vietnam	VN	Antwp/Rtrdm	32	3	1363	92,139	1,200	1.20	$ 1,635,600.00	18062	3,590,508
Vietnam	VN	UK Ports	30	3	67	4,495	1,210	1.21	$ 80,465.00	17687	171,526
Vietnam	VN	UK Ports	34	5	67	4,495	1,210	1.21	$ 80,465.00	17687	156,467
Cambodia	KH	Antwp/Rtrdm	27	2	1215	82,134	1,590	1.59	$ 1,931,850.00	17197	2,775,521
Cambodia	KH	UK Ports	35	2	95	6,402	1,620	1.62	$ 153,430.20	16857	212,346
Cambodia	KH	UK Ports	27	4	95	6,402	1,620	1.62	$ 153,430.20	16857	188,593
Cambodia	KH	UK Ports	36	5	98	6,596	1,620	1.62	$ 158,079.60	16857	233,192
India	IN	Antwp/Rtrdm	20	1	1076	72,738	821	0.82	$ 883,396.00	13137	2,834,734
India	IN	UK Ports	32	1	102	6,895	821	0.82	$ 83,742.00	13049	267,178
Thailand	TH	Antwp/Rtrdm	27	2	964	65,166	1,081	1.08	$ 1,042,084.00	17395	2,134,277
Thailand	TH	UK Ports	35	2	77	5,205	1,131	1.13	$ 87,087.00	17085	167,507
China	CN	Antwp/Rtrdm	41	5	797	53,877	1,120	1.12	$ 892,640.00	20212	2,143,150
China	CN	UK Ports	34	1	213	14,399	1,080	1.08	$ 230,040.00	20166	570,821
China	CN	Antwp/Rtrdm	37	3	253	17,088	1,290	1.29	$ 326,086.20	18936	698,114
China	CN	Antwp/Rtrdm	39	4	253	17,088	1,290	1.29	$ 326,086.20	18939	522,308
China	CN	Antwp/Rtrdm	33	5	260	17,606	1,290	1.29	$ 335,967.60	18936	656,128
China	CN	UK Ports	44	5	97	6,557	1,290	1.29	$ 125,130.00	18945	247,052
Pakistan	PK	Antwp/Rtrdm	27	1	675	45,630	636	0.64	$ 429,300.00	11561	1,347,791
Pakistan	PK	UK Ports	26	1	122	8,247	671	0.67	$ 81,862.00	11466	241,593
Malaysia	MY	Antwp/Rtrdm	20	3	402	27,175	1,125	1.13	$ 452,250.00	15801	932,351
Malaysia	MY	UK Ports	20	3	66	4,462	1,145	1.15	$ 75,570.00	15309	148,351
India	IN	Antwp/Rtrdm	27	1	281	18,996	721	0.72	$ 202,601.00	13114	735,187
Egypt	EG	Antwp/Rtrdm	17	3	195	13,182	967	0.97	$ 188,565.00	6244	240,013
Egypt	EG	UK Ports	16	3	43	2,907	984	0.98	$ 42,312.00	5000	33,736
Sri Lanka	LK	Antwp/Rtrdm	21	3	163	11,019	849	0.85	$ 138,387.00	12871	381,701
Sri Lanka	LK	UK Ports	27	5	39	2,636	850	0.85	$ 33,150.00	12710	44,594
Indonesia	ID	Antwp/Rtrdm	27	2	80	5,408	1,280	1.28	$ 102,400.00	16714	166,028
Indonesia	ID	Antwp/Rtrdm	30	5	80	5,408	1,280	1.28	$ 102,400.00	16714	177,892
Indonesia	ID	UK Ports	26	5	15	1,014	1,280	1.28	$ 19,200.00	12143	24,233
Jordan	JO	Antwp/Rtrdm	25	3	77	5,205	1,116	1.12	$ 85,932.00	6871	96,249
Jordan	JO	UK Ports	18	3	8	541	1,151	1.15	$ 9,208.00	6784	9,877
Taiwan	TW	Antwp/Rtrdm	26	1	52	3,515	1,171	1.17	$ 60,892.00	18566	128,218
Taiwan	TW	UK Ports	28	1	8	541	1,171	1.17	$ 9,368.00	18562	19,885
Honduras	HN	Antwp/Rtrdm	18	1	27	1,825	564	0.56	$ 15,228.00	9724	106,566

Tab.9 Frame of the results table. Source: Flows LT – Cost-saving.

The final result of these analyses, in terms of costs, transit time and emissions, led to the following outcome (Tab.10):

	CO2e (WTW) [M Kg]	Costs [M $]	Average Transit Time [Days]
Cost saving	81.95	42.67	26.26
Time saving			
Eco-friendly			
AS-IS			
TO-BE			

Tab.10 Cost-saving scenario results.

Resulting from a volume allocation thus distributed (Tab.11):

	LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
FY20 volume/LSP	2618	23044	2662	379	8100
% allocation	0.07	0.63	0.07	0.01	0.22

Tab.11 Cost-saving scenario volume allocation*.

The reason why such a scenario is far-fetched is that it does not meet multiple constraints, such as:

1) The allocation per provider exceeds 40% in several BIG lanes. In fact, in multiple lanes different providers have a percentage use of up to 100% (Appendix 10);
2) The allocation per provider exceeds 50% in several MID lanes. In multiple lanes, several providers have a percentage utilization of up to 100%;
3) The maximum total utilization for a single provider exceeds 40%. In this case, LSP 2 has a utilization of 63% (Tab.11);
4) The maximum total use for a single alliance exceeds 50%. In this case, the RED alliance has a percentage of 85%;
5) The minimum total percentage utilization of a single provider is below 5%. LSP 4 is only used for 1% of the total volume.

* The different colors in the table mark the existence of different alliances among the providers. In fact, LSP 2 and LSP 5 are considered as an alliance as well as LSP 3 and 4.

4.3 Scenario 2: Time-saving

Similarly to the "Cost-saving" scenario, here the allocation has been realized looking at the fastest solution possible, per lane per provider.

Rather than present once again the same figures, there will be highlighted below the main differences perceived when the lead time became the main variable (Tab.12).

	CO2e (WTW) [M Kg]	Costs [M $]	Average Transit Time [Days]
Cost saving	81.95	42.67	26.26
Time saving	**82.53**	**45.90**	**22.29**
Eco-friendly			
AS-IS			
TO-BE			

Tab.12 Time-saving scenario results.

Focusing on the transit time would, on one hand, lead to a significant reduction of the 15% on the average days spent to reach the unloading port compared to the "Cost-saving", however worse-performing both in terms of $CO2_e$ emissions (+ ~1%) and costs (+7.5%). Since the transit time is considered the most flexible variable among the three (Thoonen, Allocation process, 2019), a 15% reduction would impact the business less than the consequent 7.5% increase in the costs, due to the fact that all the transit times reflect a planning that has been done by the company in accordance with its providers. Therefore, reducing them more than what has been planned would for sure make the transports faster, however not influencing the company's business that much.

These results arose from the following allocation (Tab.13):

	LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
FY20 volume/LSP	6011	12093	1046	1951	15701
% allocation	**0.16**	**0.33**	**0.03**	**0.05**	**0.43**

Tab.13 Time-saving scenario volume allocation.

Analyzing these results, it can be noticed that also the "Time-saving" scenario violates multiple constraints:

1) The allocation per provider exceeds 40% in several BIG lanes. In fact, in multiple lanes different providers have a percentage use of up to 100%;
2) The allocation per provider exceeds 50% in several MID lanes. In multiple lanes, several providers have a percentage utilization of up to 100%;

3) The maximum total utilization for a single provider exceeds 40%. However, differently from the "Cost-saving" scenario, here the overrunning of the threshold is 3% from LSP 5, that has a utilization of 43%;
4) The maximum total use for a single alliance exceeds 50%. In this case, the RED alliance has a percentage of 76%;
5) The minimum total percentage utilization of a single provider is below 5%. LSP 3 is only used for 3% of the total volume.

4.4 Scenario 3: Eco-friendly

To analyze the last preliminary scenario, the allocation has been based on the "eco-friendliest" providers per lane, in terms of $CO2_e$ emissions.

In order to be able to rank all the 5 providers in terms of their impact on the environment, in 2012 Nike became a member of the Clean Cargo Working Group.

The value that CCWG adds to Nike's portfolio is of inexpressible importance, as it is a company that involves more than 250 stakeholders, aiming to develop and give them business strategies insights and solutions to improve their ecological footprint on global goods transportation (CleanCargo, 2014).

More specifically, each year members of the company survey the Nike LSP's to get info about how they are performing in terms of emissions to then set an emission factor for each of them for the different areas in the world from where they ship the products (Poulsen, 2019).

This, together with the help of LogEC, can bring to Nike an important value-added, allowing the company to monitor its emissions as accurately as possible.

In fact, once the emission factors are determined, they are then fed into the software to create/refresh the values for all the vessels, thus always having the most updated version for each provider.

Vehicles		CO2e (WTW) per TEU-km [g]				
		LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
CCWG_NIKE_DRY6	Asia to-from North Europe	46.786	43.716	51.348	38.411	46.84
CCWG_NIKE_DRY11	Europe (North & Med) to-from Middle East/India	60.807	65.721	64.052	53.774	31.678
CCWG_NIKE_DRY10	Europe (North & Med) to-from South America (incl. Central America)	130.297	60.984	68.847	69.066	
CCWG_NIKE_DRY19	North Europe to-from North America EC/Gulf	104.754	92.302	65.102	93.546	92.609
CCWG_NIKE_DRY20	North Europe to-from North America WC			67.083	68.464	

Tab.14 Emission factors per provider per area. Source: LogEC

Table 14 shows how the five providers perform in terms of transportation emissions, and it can be noticed that the values differ quite significantly from an area to another, depending on the feedbacks that CCWG receives from them.

Following the scenario's principles, the results achieved from the eco-friendly allocation can be summarized as follows (Tab. 15):

	CO2e (WTW) [M Kg]	Costs [M $]	Average Transit Time [Days]
Cost saving	81.95	42.67	26.26
Time saving	82.53	45.90	22.29
Eco-friendly	**68.27**	**45.26**	**27.75**
AS-IS			
TO-BE			

Tab.15 Eco-friendly scenario results.

From these outcomes, table 15 shows how big the savings in $CO2_e$ would be if Nike would only focus on being green as much as possible. In fact, "be green" would reflect into an 18% reduction compared to the other preliminary scenarios, however disadvantaging the lead time, that would become the highest among the three.

To be able to get these results, the volumes have been split as noted below (Tab. 16):

	LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
FY20 volume/LSP	0	121	45	33853	2784
% allocation	-	0.003	0.001	0.92	0.076

Tab.16 Eco-friendly scenario volume allocation.

As for the previous scenarios, the "Eco-friendly" doesn't meet multiple constraints:

1) The allocation per provider exceeds 40% in several BIG lanes. In fact, in all the lanes it is 100% for one provider and 0% for all the others, due to the fact that nobody has the same values in terms of emissions;
2) The allocation per provider exceeds 50% in several MID lanes. In all the lanes, several providers have a percentage utilization of 100%;
3) The maximum total utilization for a single provider exceeds 40%. In this case, LSP 4 has a utilization of 92%;
4) The maximum total use for a single alliance exceeds 50%. In this case, the BLUE alliance has a percentage of 92.1%;

5) The minimum total percentage utilization of a single provider is below 5%. Besides the LSP 4 and LSP 5, all the others have a utilization of not even 1%, with LSP 1 that was never used;
6) The average price per container is above the allowed threshold. In this case, the mean of all the prices per container exceeds the threshold by 11%.

4.5 AS-IS scenario

Once the preliminary analyses have been performed, it is now possible to begin the analysis of the core phase of the project, meaning that of evaluating and consequently optimizing the sustainable performance of the Inbound Transportation team.

Differently from the other scenarios, where the first step consisted on creating the allocation before running the different simulations to get the results, here this step was skipped, and the evaluation of the performances was based on the already determined volume allocation for FY2020, which led to the creation of the starting scenario, previously named "AS-IS" (Appendix 10).

Among the factors that determined this allocation:

- Cost
- Lead Time
- Delivery performances
- Risk mitigation. Given the large amount of volumes transported in BIG and MID lanes, the company preferred to divide them as equal as possible among its LSP's, with the aim of having a balanced allocation on an alliance basis to mitigate the risk and prevent that a failure on a lane could compromise the transport of the totality of the volumes, therefore having a backup solution.

The analysis of this scenario has a two-pronged objective:

1) Place the scenario within the radar chart, in order to understand how much the results in terms of costs, lead times and emissions differ from the optimal values previously obtained with the others;
2) Get a vision of how the Inbound team is expected to perform from an environmental point of view without having incorporated emissions as a decision variable within the allocation process.

4.5.1 Scenarios' comparison

If for all the other scenarios the allocation had to be determined based upon their leading criteria, the AS-IS case took the allocation made by the team at the beginning of the fiscal year 2020 (Tab.17):

	LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
FY20 volume/LSP	11111	4675	4477	7529	9010
%	**0.30**	**0.13**	**0.12**	**0.20**	**0.24**

Tab.17 AS-IS scenario volume allocation.

The analyses carried out from this scenario brought to light the following results (Tab.18):

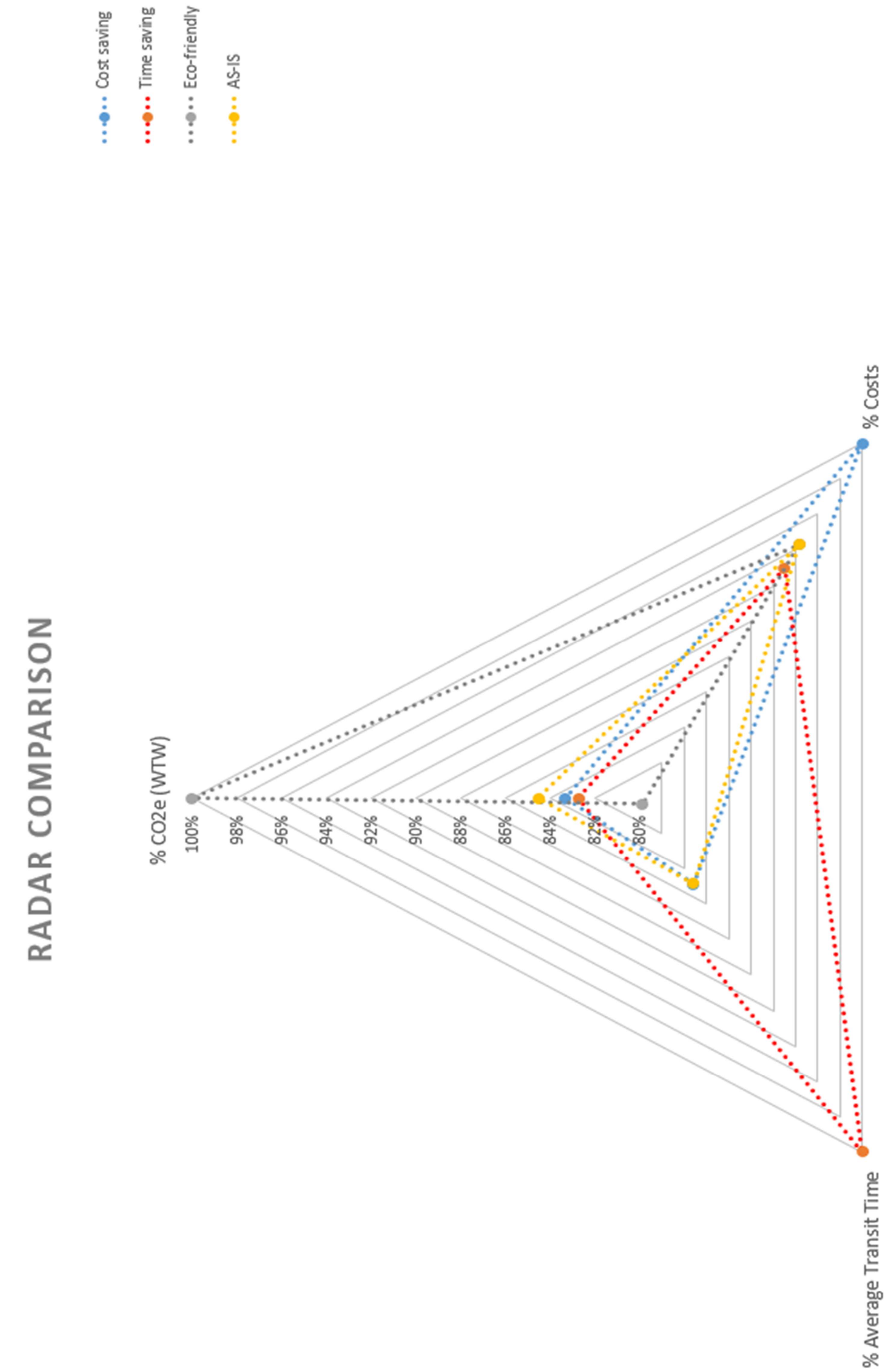
	CO2e (WTW) [M Kg]	Costs [M $]	Average Transit Time [Days]
Cost saving	81.95	42.67	26.26
Time saving	82.53	45.90	22.29
Eco-friendly	68.27	45.26	27.75
AS-IS	**80.79**	**45.26**	**26.27**
TO-BE			

Tab.18 AS-IS scenario results.

Since the analysis of the "TO-BE" scenario will be mainly based on a two-way comparison with the current one, the first conclusions for the four scenarios assessed so far can now be drawn.

The purpose of such an assessment aims to examine how a real scenario as that "AS-IS", in line with what are the constraints that the company wants to respect for an allocation process, is placed in the presence of three ideal situations.

The goal, therefore, is to evaluate its performances and how far they are from the optimum. To get a better understanding of table 18, a graph is made in order to depict the results (Fig. 15).



	Cost saving	Time saving	Eco-friendly	AS-IS	TO-BE
% CO2e (WTW)	83%	83%	100%	85%	
% Costs	100%	93%	94%	94%	
% Average Transit Time	85%	100%	80%	85%	

Fig.15 Radar comparison

The purpose of this graph is explained earlier in par. 4.1 along with its benefits.

It can, therefore, be noted that, in total, the AS-IS scenario is the most balanced of the four, being the one that:

- Is closer to the optimum in terms of $CO2_e$ emissions, with a percentage of 85%;
- Has the best cost-efficiency, as well as the "Eco-friendly" scenario, only 6 percentage points far from the optimal solution;
- Shows the fastest solution, in common with the "Cost-saving" scenario;
- Respect all allocation constraints.

Once this scenario is confined to the three decision variables, the most interesting challenge now is to create a model that can optimize its outcomes.

4.6 TO-BE scenario

The creation of a "TO-BE" scenario aims to improve the performance of the "AS-IS" scenario, in such a way as to justify how the incorporation of a variable, such as sustainability, in the volume allocation process can, on one hand, bring a significative added value to the Inbound team, and on the other hand, give a valid answer to the main objective of the project.

In fact, the purpose of creating this case is to experimentally explain how the carbon footprint can be introduced into a business decision process such as that of the volume allocation.

4.6.1 Optimization of the allocation process

In order to propose a feasible solution to optimize the allocation process, a first refinement of the tools was needed to understand which model could be created to be then implemented.

Since the methodology adopted by the Inbound team to complete the volume allocation process has a strong manual working component, it might be time-consuming.

The goal of the leadership is, therefore, to be able to automate - where possible - steps that can reduce these uses.

As a result, the project will now present the creation of a model that can, once fed with the necessary data, directly provide an optimal solution for a given function. The first criterion that it must meet is to take into account all the three core variables – costs, lead times, and emissions – not forgetting what are the constraints to which they must comply.

Because these variables and constraints can be expressed linearly, the model that was chosen for the optimization process is a linear programming model.

In order to create such a model, the following elements had to be defined:

- **Objective variables:** variables of the system whose value is unknown and on which it's possible to act to determine different solutions;
- **Objective function:** a function that determines the operator that will define what to do with the objective variable: maximization or minimization;
- **Constraints:** conditions that must be met by the model in order to achieve the optimal solution.

4.6.2 Linear programming model: Excel Solver

The software chosen for the definition of the linear programming model was an Excel add-in, called "Solver". This tool allows the user to carry out multiple "what-if" analyses, generating an optimal solution for either a maximization or minimization problem for a certain decision variable. To do so, a preliminary elements' definition phase is required. More specifically, the factors that have to be specified are:

- **Objective**: variable to either maximize or minimize;
- **Variable cells**: cells whose value will be changed by the solver to meet the objective;
- **Constraints**: values that the program must meet in order to give back an optimal solution that satisfies all of them.

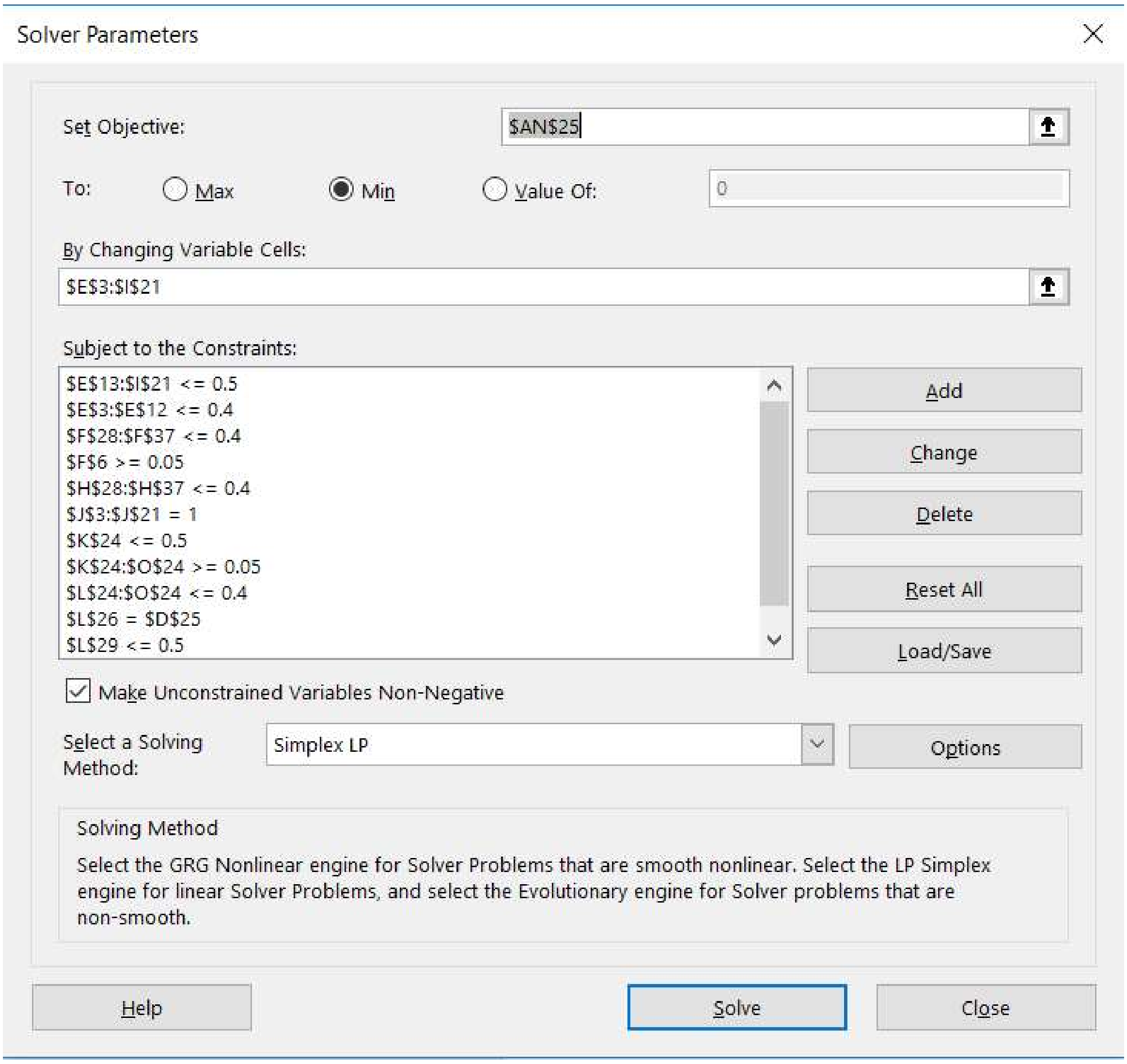


Fig.16 Excel Solver

To better understand what written previously, figure 16 gives an insight into how the tool setting process looks like.

Besides the definition of the three key elements, the solver needs to be told which method has to be used to process the information and find the final solution. In the "TO-BE" scenario's case, as the three variables are all linear, the solving method used was the "Simplex LP".

In order to contextualize the tool in the analysis of that scenario, an explanation of how the set-up of the data set was performed is presented below.

For the selection of the decision variables, although the scenario is a three-variable optimization model, the fact that the main objective of the research is to find an experimental explanation of how sustainability can be incorporated into the volume allocation process made this variable the protagonist, with the aim of minimizing the total $CO2_e$ emissions for maritime transports in the EMEA regions.

Therefore, for the cost variable, since the company does not aim to minimize it, but rather tends to have a total cost per container below a certain threshold (Thoonen, Allocation process, 2019), it has been decided to enter it into the data set as a hard constraint.

For the lead time, instead, the preliminary determination of the "planned lead times" between Nike and its LSP's made this variable the most flexible among the three, thus taking into account the final average transit time and discussing its value only once the allocation was determined.

For what concerns the **variable cells**, the solver in this case acted on the percentage use of each LSP, per lane. These cells were grouped under the category “ALLOCATION” (Fig.17).

			ALLOCATION				
Origin City	Destination City	FY20 volume	FY20 allocation LSP 1	FY20 allocation LSP 2	FY20 allocatio n LSP 3	FY20 allocation LSP 4	FY20 allocatio n LSP 5
Vietnam	Antwp/Rtrdm/Zbrg	11328	0.20	0.40		0.40	
Indonesia	Antwp/Rtrdm/Zbrg	7224	0.20	0.40		0.40	
China	Antwp/Rtrdm/Zbrg	2726	0.20	0.40		0.40	
China	Antwp/Rtrdm/Zbrg	2230	0.20	0.17		0.40	0.23
Vietnam	UK Ports	2041	0.20	0.40		0.40	
Vietnam	Antwp/Rtrdm/Zbrg	1363	0.20	0.40		0.40	
Cambodia	Antwp/Rtrdm/Zbrg	1215	0.20	0.40		0.40	
India	Antwp/Rtrdm/Zbrg	1076	0.20			0.40	0.40
Indonesia	UK Ports	1048	0.20			0.40	0.40
Thailand	Antwp/Rtrdm/Zbrg	964	0.20	0.40		0.40	
China	Antwp/Rtrdm/Zbrg	797			0.50	0.50	
China	Antwp/Rtrdm/Zbrg	766			0.50	0.50	
Pakistan	Antwp/Rtrdm/Zbrg	675			0.44	0.06	0.50
Malaysia	Antwp/Rtrdm/Zbrg	402			0.50	0.50	
China	UK Ports	324			0.50	0.50	
China	UK Ports	292			0.50	0.50	
Cambodia	UK Ports	287			0.50	0.50	
India	Antwp/Rtrdm/Zbrg	281			0.00	0.50	0.50
China	UK Ports	213			0.50	0.50	

Fig.17 Variable cells, TO-BE scenario

For the complete allocation template that was made by implementing the solver, see Appendix 11.

The critical part of the programming phase of the tool is the definition of constraints. They determine the scope for action of the model, and whether or not it can still provide an optimal solution.

Their definition took place at first instance verbally with the manager of the Inbound Team in order to match them with the strategy requirements. This phase enabled to roll out some guidelines to define the constraints, such as the willingness to have a balanced split of the volume among the alliances, don't exceed a certain allocation's threshold both for a single LSP and for an alliance and mitigate the risk for the most intensive lanes (e.g. BIG and MID).

The next step was their transcription in the form of code in Excel. In order to implement the programming model in a consistent and constraint-like manner, a step-by-step check was performed each time a constraint entered the code.

Each of them was, therefore, given a subsequent check to make sure that there were no obstructions of any kind, allowing the solver to always find an optimal solution. This check was carried out by activating the solver and seeing if it could still be able to provide a solution.

All the information which the solver was fed with are written below:

OBJECTIVE	min $\sum_{i=1}^{n} CO2e_i$
CHANGING VARIABLE CELLS	Allocation cells ($E$3:$I$21)
LIST OF CONSTRAINTS	BIG lanes = each LSP 's allocation can't exceed 40%
	MID lanes = each LSP's allocation can't exceed 50%
	Sum utilizations = % big-mid volumes
	Sum allocations per lane = 1
	Max utilization per single LSP = 40%
	Max utilization per single alliance = 50%
	Min utilization per single LSP = 5%
	Average price/container ≤ $ 1,324.62

Note: The solver has been implemented only for the BIG and MID lanes. The reason why it wasn't applied also for the SMALL lanes lies in the fact that this allocation was both based on the delivery performances of the selected LSP's and on the lack of performances of the others. Therefore, to get an allocation as truthful as possible, it was decided to keep the SMALL lanes without any change.

4.6.3 Results

As for the previous scenarios, this paragraph aims at showing the outcomes resulted from the implementation of the analyzed scenario.

This time, however, there will be only a small mention to the preliminary cases since the main focus is on making a comparison between the "TO-BE" and the "AS-IS" models to see both whether a volume reallocation would have been worth to be considered and if sustainability should be incorporated in such a process, hence changing the way the team would approach it in the coming years.

Once the solver was properly fed with all the necessary data, its execution resulted in the following allocation (Tab.19):

	LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
FY20 volume/LSP	6424	11244	2287	14627	2221
% allocation	0.17	0.31	0.06	0.40	0.06

Tab.19 TO-BE scenario volume allocation.

The first outcome that can be caught from table 19 is the balanced deployment of the volume among the three alliances, with an allocation of ~20% for the BLACK and almost a ~40% allocation for the other two.

In addition, an explication can be given for how the volume was spread among the two colored alliances. In fact, as can be noticed for the BLUE and RED alliances, the low amount of volume allocated to two LSP's reflects a situation where they performed worse in terms of emissions. Therefore, the other two members are considered as the main ones, with the possibility to share part of the volume with their associated if necessary, thus increasing their allocation percentage.

A situation that might forces this to happen, for example, could be the missed cut-off date for the loading of a vessel for a member of an alliance, with the consequent utilization of its respective associate to cope with the failure.

To be able to quantify in numbers these allocations, a summary table with all the results got from the different analyses has been realized (Tab.20):

	CO2e (WTW) [M Kg]	Costs [M $]	Average Transit Time [Days]
Cost saving	81.95	42.67	26.26
Time saving	82.53	45.90	22.29
Eco-friendly	68.27	45.26	27.75
AS-IS	80.79	45.26	26.27
TO-BE	**76.75**	**45.38**	**26.68**

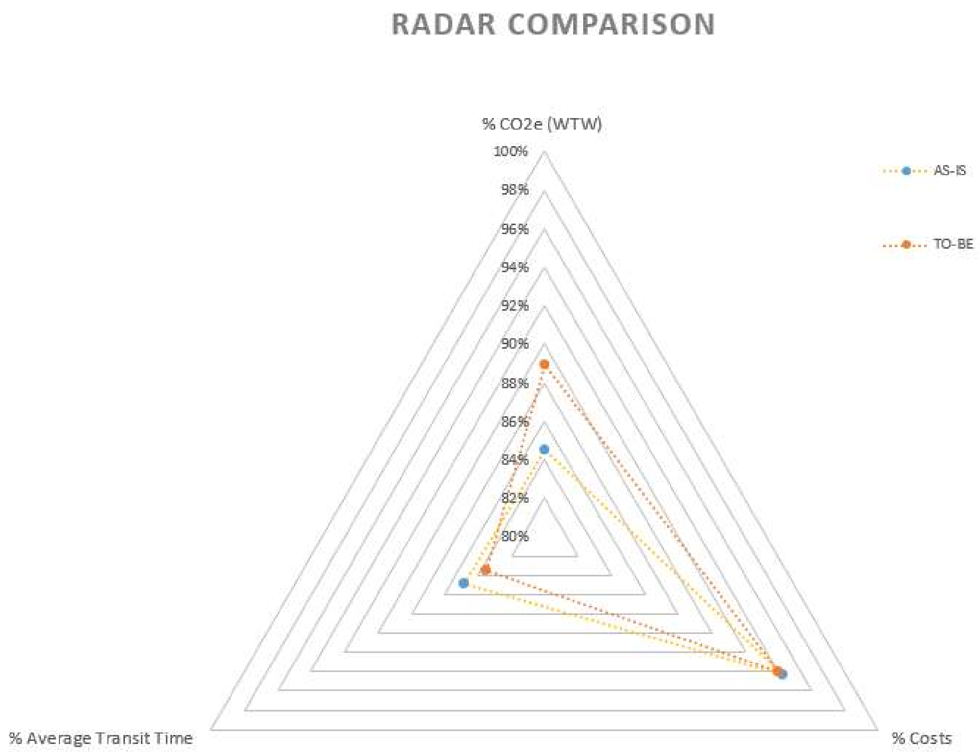
Tab.20 TO-BE scenario results.

Focusing on the two last scenarios, several conclusions can be drawn looking at their results. More precisely, the so implemented "TO-BE" model would have brought to the company around 5% savings on $CO2_e$ emissions, with not even a 1% increase in the costs and a slight increase of the 1.6% for the transit times that, as previously mentioned, would have still been acceptable due to the flexibility the company has towards the variable.

A table (Tab.21) and a graph (Tab.22) have been realized in order to capture all the outcomes arising from this comparison:

	AS-IS	TO-BE	%
CO2e (WTW) [M Kg]	80.79	76.75	-5%
Costs [M $]	45.26	45.38	0%
Average Transit Time [Days]	26.27	26.68	1.6%

Tab.21 AS-IS – TO-BE results comparison.



Tab.22 Radar comparison.

The complete graph can be found in Appendix 12.

Table 21 enables the drafting of different conclusions:

- The linear programming model has shown its potentialities throughout the execution of the above scenario. Among them, the reduction of manual workload by just converting constraints into codes, and the $CO2_e$ savings that it could bring without heavily impacting costs and lead times;
- Sustainability can fit within a business decision process, bringing the company a new value-added. In fact, it's known that stakeholders are always more interested in seeing companies taking care of their impact on the environment (EMEA Sustainability Team, 2019), and the 5% reduction in $CO2_e$ emissions – reflecting in a ~5 M $CO2_e$ kg cut – would have resulted in the saving of ~950 000 trees*;
- The results were already expected to not reach the -20% reduction target set for the FY2020 since it's not just by changing a template that such big leaps can be achieved. Therefore, the implementation of a new reallocation method could be a part of a larger scope where other initiatives take part (e.g. investments in alternative fuels, air freight banning).

4.7 Other alternatives

The main objective of this paragraph is to find complementary solutions, with regard to maritime transport, to the optimization model proposed in the previous, in order to bring to light different areas from which Nike could benefit to further improve its carbon footprint. As already discussed in chpt. 3, an alternative that the company has been promoting for two years concerns air freight banning, whose positive success is mostly linked to the improvement of the planning phase (Papoutsis, Shipments planning, 2019).

Therefore, the main focus that will be addressed in this paragraph is the implementation of alternative fuels to power ships.

Ocean shipping transports around 90% of cargos all over the world, and this reflects in the consumption of hundreds of Mt of fuel per year. Estimates state that this consumption is responsible for 2-3% of CO_2, 4-9% of SOx and 10-15% of NOx global

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* The conversion criterion has been agreed with the Sustainability Director at ELC, Mike van der Zanden, and reflects the calculation the company uses at EMEA. The proportion is 5,2 kg CO_2 per tree, per year. This is the average of tree absorption for the type of forest Nike already supports through its "We Forest" project (plantation of trees in the Atlantic forest in Brazil to offset digital delivery in Europe) (Zanden, 2020).

emissions (Benetti, 2018).

Along with these percentages, the main fuels that power most of the vessels are Heavy Fuel Oil (HFO) and Marine Diesel Oil (MDO), whose pollution content causes severe effects on air and water (Benetti, 2018). Consequently, the IMO (International Marine Organization) decided to tighten, in 2018, the regulation measures applied to maritime transportation, crating Emission Control Areas (ECAs) in coastal waters. As a result, no vessel that is powered with fuel with more than 0.5% of sulfur is allowed to sail.

It's, therefore, necessary for companies to find alternative solutions to keep running their businesses and being able to deliver their products via sea; one of them lies in the implementation of alternative fuels, whose main aim is that of reducing the environmental impact by cutting the transportation's emissions.

4.7.1 Alternative fuels

In order to give an explanation of how alternative fuels could better influence the CO2 footprint of a company, a research analysis of three fuels – LNG, Biofuel, and Hydrogen - have been performed, tackling three main fields:

- **Nature of the fuel**;
- **Environmental impact**. It accounts not only for CO2 emissions but also for other pollutants as SOx and NOx, which affect both air and water conditions;
- **Benefits & Drawbacks**.

The aim of such analysis is, firstly, to get an overview of the most suitable alternative fuels that could match the actual needs arisen from environmental concerns, focusing on their advantages and disadvantages.

Secondly, it will provide a theoretical answer to what has been defined as the second research question of the project.

To help the deployment of the analysis, a table (Tab.23) has been realized.

Fuel	Nature	Environmental impact	Benefits & Drawbacks	
			Pros	*Cons*
LNG	Natural gas - mainly methane - condensed into liquid form	- 30% CO2 emissions reduction onboard. Value drops down to 10-15% - 99% reduction in SOx - 85% reduction in NOx	- Volume reduction of 600 times when condensed = easy to transport - High availability and duration of reserves (200 years against 50 for oils) - Already available technology	- Volume factor = 1.8 - Low availability of fueling stations - Not sustainable - Highly inflammable - Expensive infrastructure
BIOFUEL	Fuel produced from biomass (e.g. food, crops)	- 100% CO2 emissions reduction (TTW) - 80% CO2 emissions reduction from latest-generation biofuels (WTW) - 85% CO2 emissions reduction from second-generation biofuels (WTW) - +2% NOx emissions for B20 and +13% for B100 - -20% in SOx emissions for B20, -100% for B100	- Highly biodegradable - Renewable energy - Easy to source - Adaptable to fossil fuels engines - Carbon neutral	- Industrial pollution - Indirect effects on food shortage - High amount of water usage - Indirect carbon emissions along the product value chain - Careful storage required - Blend with fossil fuels to increase efficiency
HYDROGEN	Zero-emissions fuel burned with oxygen. It can be used in fuel cells or typical internal combustion engines	- 100% * reduction in CO2 emissions - 100% * reduction in SOx emissions - 100% * reduction in NOx emissions	- Complete cut off of CO2 emissions if clean hydrogen is used - Renewable - Non-toxic	- Majority of hydrogen derived from fossil fuels - Volume factor = 4.7 (H2 liquid) and 8.6 (pressurized 700 bar) - Not mature enough - Highly inflammable - Expensive pipelines - Discouraged for large vessels

Tab.23 Alternative fuels comparison

LNG

Liquified Natural Gas (LNG) is a natural gas, whose main source is methane, which is condensed into liquid form. Its environmental impact, considering the entire lifecycle, is highly influenced by the methane slip and leakage that are released in the atmosphere throughout the extraction, transportation, bunkering, and onboard use. Therefore, the estimated 30% reduction in CO2 emissions falls down to 10-15% (Executive, 2019).

On a sulfur and nitrogen level, the reduction is important as it reaches respectively 99% and 85% (CMA-CGM, 2019).

Besides the environmental impact, which in numbers might be the most attractive data to look at, there are several aspects that must be taken into consideration for the evaluation of a precise type of fuel.

When it comes to LNG, for example, even though the condensation phase reduces its volume by 600 times, its volume factor is equal to 1.8, meaning that if the vessel shifts from HFO to LNG, the space required to store the fuel would be 1.8 times the volume to store the HFO, without considering the space needed to store the different technologies to power it (F.Volger & G.Sattler, 2016).

In addition, the availability of bunkering stations is not high right now, the gas itself it's not renewable, it's highly inflammable and not easy to detect since it's both odorless and tasteless, and both the pipelines needed to power it and the bunkering infrastructures are expensive.

However, LNG has already a significant market availability, the reserves are expected to last many years (200 years against 50 for oils) (SLNG, 2019) and the technology to implement it is already in place as it uses the same as the fossil fuels to be produced.

BIOFUEL

Biofuels are fuels produced from biomass (e.g. food, crops). There are different kinds of biofuels, divided into generations, from the first to the fourth one, where the main difference is the type of biomass used (Aro, 2015). As an example, first-generation biofuels are fuels made from food crops while second-generation are sourced from wastes (e.g. cooking oil).

In terms of emissions, the contribution this fuel can provide is high since it can reduce CO2 emissions, on a Tank-To-Wheel (TTW) basis, by 100%, and this value would only drop to 80-85% if emissions are considered along the entire product value chain (WTW). To testify it, pilot studies have been launched by an ocean provider, CMA CGM, in partnership with one of its customers, IKEA, and a company called Good Shipping (International, 2019). The test foresaw the sailing of a vessel from Asia to North-Europe, powered by a latest-generation biofuel blended with conventional fossil fuel, and that called at the port of Rotterdam in March 2019. The results that arose from this test were positives and confirmed the potentialities that biofuels can have on emissions reduction (Magazine, 2019).

Similarly to CMA CGM, another provider, Maersk, launched in June 2019 its biofuel trial from Rotterdam to Shanghai, powering a vessel with a 20% second-generation biofuel, produced from cooking oil (UCOME oil) to test whether the outcome will follow the expectations of reducing CO2 emissions by 85% (Maersk, 2019).

Along with the reduction in CO2 emissions, depending on the percentage of blends of biofuel with fossil fuels, there are different impacts on sulfur and nitrogen oxide emissions.

In general, biofuels positively impact SOx emissions while negatively affect NOx ones. Table 23 shows how a B20 biofuel (meaning biodiesel blend that is 20% mixed with petrodiesel) has a slight increase in NOx emissions, ~2%, and a 20% reduction in sulfurs while a pure biological sourced fuel (B100) is sulfur-free, emitting an higher amount of nitrogen oxides – 13% – compared to fossil fuels (S.Prasad & M.S.Dhanya, 2011).
Differently from LNG, among its pros, biofuels are highly biodegradable and renewable (compared to fossil fuels that take hundreds or thousands of years for their production, the production of biofuels take decades) (Greencoast, 2019), and are easy to source since they're made from crops, plants, food, and wastes.
From a technological point of view, they're adaptable to fossil fuel engines without the need of making big changes, and they're considered carbon neutral. It means that when burned they emit the same amount of carbon accumulated during the growing phase of the plant, hence resulting in zero net CO2 emissions.
Although there are many advantages in using and implementing biofuels, some side effects arise upstream the product value chain. In fact, fertilizers are needed in order to let the crops grow better. This reflects in the emission of carbon dioxide, methane, and nitrogen. Alongside with that, a large use of water is needed to irrigate the crops and their resultant effect is, on one side, that of indirect emissions in the atmosphere, while on the other one, a shortage of food since the crops are the same used as food crops (Energy C. F., 2019).
Considering the storage process of the fuel, it has to be treated carefully as the fuel can easily degrade due to oxidation, contact with water and other microbial activities (Energy F. , 2019).

HYDROGEN

Hydrogen is a zero-emissions fuel burned with oxygen that can be used in fuel cells or typical internal combustion. Among the three, its potentialities are the most powerful, as it can reduce CO2, SOx and NOx emissions by 100%, resulting in a zero-emissions, renewable, and non-toxic fuel, as its definition states.
However, these percentages drop down if clean hydrogen is not produced. In fact, it's not easy to have pure hydrogen since it's usually made through electrolysis – using fossil fuels – or via combustion. The reaction results, therefore, in the production of both hydrogen and fossil fuels, releasing CO2 in the atmosphere. The ideal situation would be, therefore, to have an electrolysis reaction where the electric energy involved comes from renewable energies, hence allowing to produce pure hydrogen (Cartwright, 2018).

Although the huge potentialities hydrogen has as a fuel, some drawbacks arise:

- At the moment, the majority of hydrogen is derived from fossil fuels (e.g. heating coal, oil, and natural gas), hence always emitting a certain amount of CO2 (IEA, 2019);
- Its volume factor is equal to 4.7 if we consider liquid hydrogen. It rises up to 8.6 if pressurized hydrogen is taken into consideration;
- The volume factor discourages the utilization of hydrogen for large vessels as it would require a big storage volume;
- It's highly inflammable;
- Companies are still not willing to invest in it since its technology is not mature enough yet;
- Expensive infrastructure costs. However, some companies are trying to investigate ways to reduce these costs. As an example, Snam, the main regulated gas utility in Europe, tested in April 2019 the injection of a mix of 5% of hydrogen into natural gas pipelines (Snam, 2019). The trial was a success, so the infrastructure costs of hydrogen might not be a problem in the next future.

In conclusion, the above analysis shows how differently each alternative fuel acts and how differently it can impact the environment.

LNG looks like the most suitable and affordable fuel to go in the short/mid-term, as it's already marketed, the availability of the reserves is high, the technology to produce it is already in place, and the fuel cost is lower than fossil fuels. However, what stops LNG to be seen as a long term solution is its emission efficiency, the low availability of bunkering stations and the costs foreseen to implement them.

On the other side, biofuels seem to represent the next future solution due to its high impact on emissions and pollutants reduction and its carbon neutral properties. To testify it, the fact that some of the biggest ocean shipping companies are investing in them, launching different trials to ascertain their efficiencies.

The big drawback, as previously explained, is the indirect effect it might have on the environment along its value chain, mostly upstream.

If LNG represents the short/mid-term solution, and biofuels the next future, hydrogen might have a crucial impact on the entire ocean transportation in the long run. In fact, to meet the targets set both in the Paris Agreement and by the UNFCCC, powering vessels with a zero-emission fuel can be determining. The main challenge is, however, to find solutions to have enough renewable energies to produce pure hydrogen, hence resulting in a 100% emissions reduction. However, some companies are already acting to try to turn the drawbacks into benefits, and the Snam trials with the pipelines' injection is a demonstration on how much they believe and they're willing to invest in this type of fuel.

5 Conclusions and outlooks

The willingness to maintain its leadership role as a sports brand, together with the inclination of being customer-centered - through the ASAP vision – has always brought Nike to look at initiatives that could increase its prestige and fame while aligning with what its customers' needs are.

Therefore, due to external pressures from customers alongside with personal commitments that people inside the company want to have towards sustainability, Nike reorganized its strategy, making the environmental impact part of it: demonstrations of that are the adhesions to both the Paris Agreement and UNFCCC to put in place initiatives to reduce its carbon footprint.

On a transportation level, upstream in the supply chain - in the Inbound team - managers have always been ready to invest and explore new opportunities that could reduce the impact those transports have on the environment.

The ultimate goal of the project was, therefore, to find out how the sustainability performances of the Inbound team could have been improved to contribute reaching the target of a 20% reduction in $CO2_e$ emissions that the company set at the beginning of the FY20 for the entire Transportation team.

This report has first presented how the Inbound flow is conceived, which means of transport are used and how is it actually impacting the company's carbon footprint. The reason for such analysis was to find out, both through interviews and desk researches, data and trends of the main means of transport used. The research brought to light, on one hand, that on average 90% of the products are shipped via vessels each year, while on the other one, that air-freighted products are the ones that pollute the most among Nike's means of transport portfolio. Although the high pollution level of air freight, since some actions have been already put in place to reduce its impact (e.g. AF banning), and the trends showed that its percentage use decreased in the past years, the results guided the following analyses to concentrate on the main branch used to deliver products to customers, which is the maritime transport, hence being able to focus on giving the answer to the two proposed research questions.

The resolution of the first research question demonstrated how big the capabilities of incorporating sustainability into the volume allocation process could be, potentially reducing the $CO2_e$ emissions by 5 M kg, resulting in ~950 000 trees saved, without compromising the other decision variables. To testify its contribution, the fact that the optimization model that has been proposed has also been presented in front of the leadership team of the company, with the consequent will to implement it in the new tenders' process, using Nike EMEA as a pilot, eventually extending it to the other geos.

At the same time, the awareness that the optimization of the allocation process alone could haven't reached the 20% reduction target allowed to provide an answer to the second research question throughout deep desk researches to understand the impact that alternative fuels could have on the maritime transport.

What has emerged from these researches was that three different alternative fuels such as LNG, Biofuels, and Hydrogen, could likewise differently contribute to reducing $CO2_e$ emissions, respectively in the short, mid and long-term, each with its own perks and drawbacks.

However, in order to be able to support the business, guiding the company through the next steps that need to be taken in order to fully implement the above solutions, some recommendations are provided.

The first one would be that of improving the *accuracy and reliability of the dataset* Nike lies on. These data come from its carriers, and at the moment the company is not able to trustfully measure its performances, monitor KPI's and take decisions since some of the data in the system are either inaccurate or missing. The consequence is that also the sustainability performances are affected since the source from where they're calculated and monitored is the same.

Therefore, the recommendation would be that of acting directly at the source of the problem - meaning at a carrier level – in two different phases:

1) Address to each carrier its own issues and inform them about the benchmark the company wants to reach on a data accuracy level;
2) Establish a frequent connection (e.g. weekly) with each carrier to monitor the evolution of their performance and to actively interact with them if further fixings are needed.

The second recommendation lies mostly in how Nike monitors its emission through the usage of LogEC.

So far, the company, in partnership with the Clean Cargo working group, has monitored its emissions through surveying its LSP's to then set their emission factors, and they change mostly from continent to continent (e.g. Asia-to-North Europe). Therefore, Nike takes averages on a continent-to-continent level, per carrier.

The recommendation, here, would be that of *enlarging the scope of the emissions dataset*, trying to focus instead on an origin/country-to-destination level, having, on one side, more vehicles per carrier that would, however, most likely reflect the reality since each origin/country is dedicated to a specific amount of containers to be shipped, with their own distances as well as planned transit times.

One last recommendation is a direct consequence of the previous one. A more detailed dataset means a higher amount of data to manage, consequently reflecting in a higher complexity that would need to be taken into account in the proposed optimization model. However, the actual model has been realized using the Excel Solver, whose capabilities are limited as it can't act on more than 200 variable cells and on more than 100 constraints cells. Therefore, the utilization of the solver might not provide a global optimum.

Hence, the recommendation would be that of *moving into a more sophisticated optimization tool* such as CPLEX, a tool that is able to process a higher amount of variables and constraints than Excel Solver.

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Appendix

Appendix 1: Origins distribution

Nike's origins. Source: Introduction to Inbound Transportation

All the origins are depicted in this figure. They are located around 40 countries and count ~700 factories among which the ones in Vietnam, Indonesia and China serve the most volume (orange and red dots).

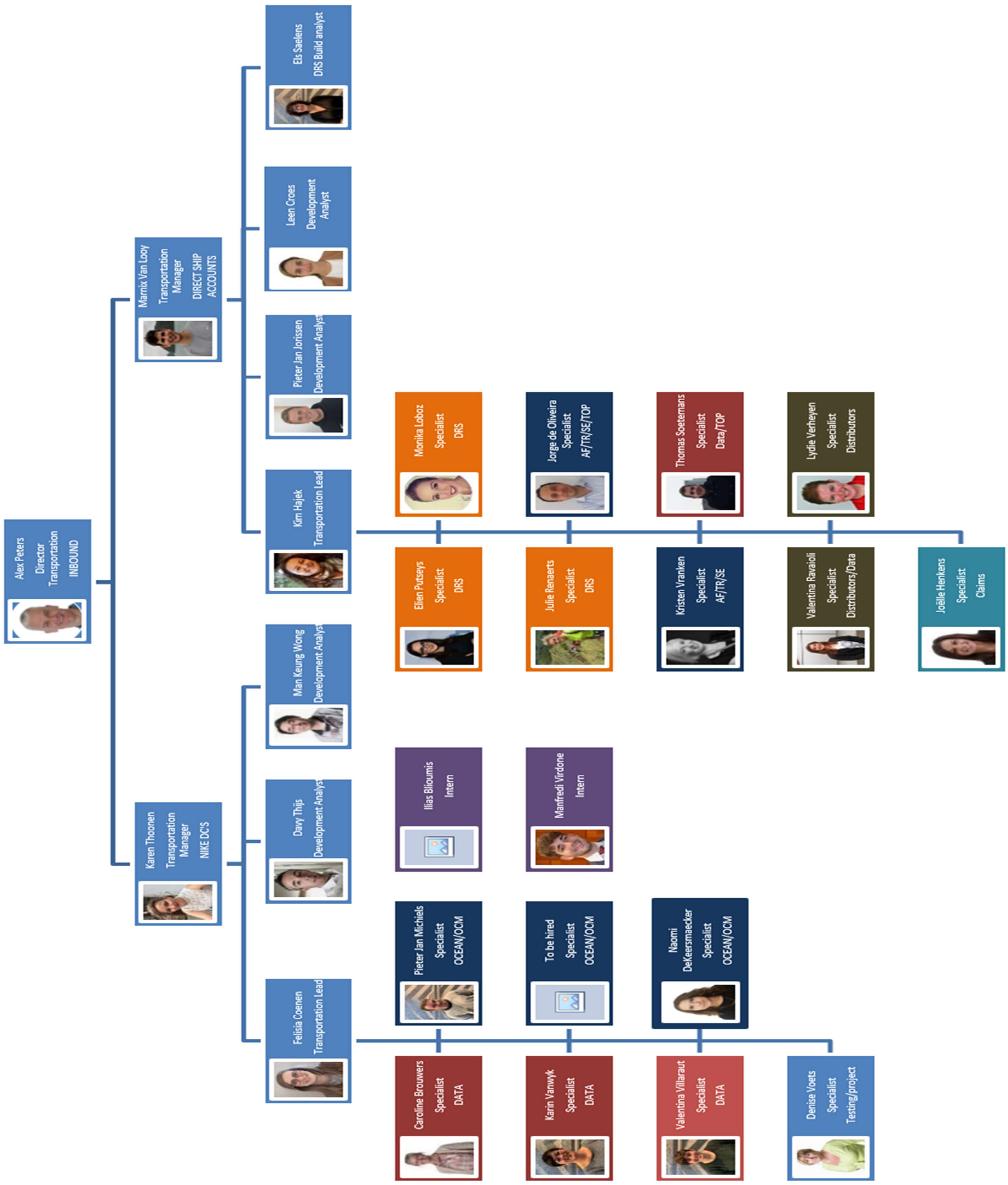
Appendix 2: Overview of Nike ELC

Nike's facilities in Laakdal. Source: Onboarding TCP Teammates

In this figure, all Nike's facilities in Laakdal are presented and labeled with their respective opening years. However, the latest building, 'The Court', is missing, and it's located next to the 'Wings' DC (Wauters, 2019). Therefore, the European Logistics Campus consists of six distribution centers (they will be five soon since the one in Herentals will be closed in the next months).

Future projections estimate that the structure of the flows will change in the next years. In fact, the company wants to reduce the DC flow meanwhile increasing the DRS one. Among the reasons, the high inventory level, holding costs and Cost per Unit (these lasts are ~50% more expensive than the DRS) (ELC, 2019).

Appendix 3: Inbound Organigram



Inbound Team Org.chart. Source: Introduction to Inbound Transportation

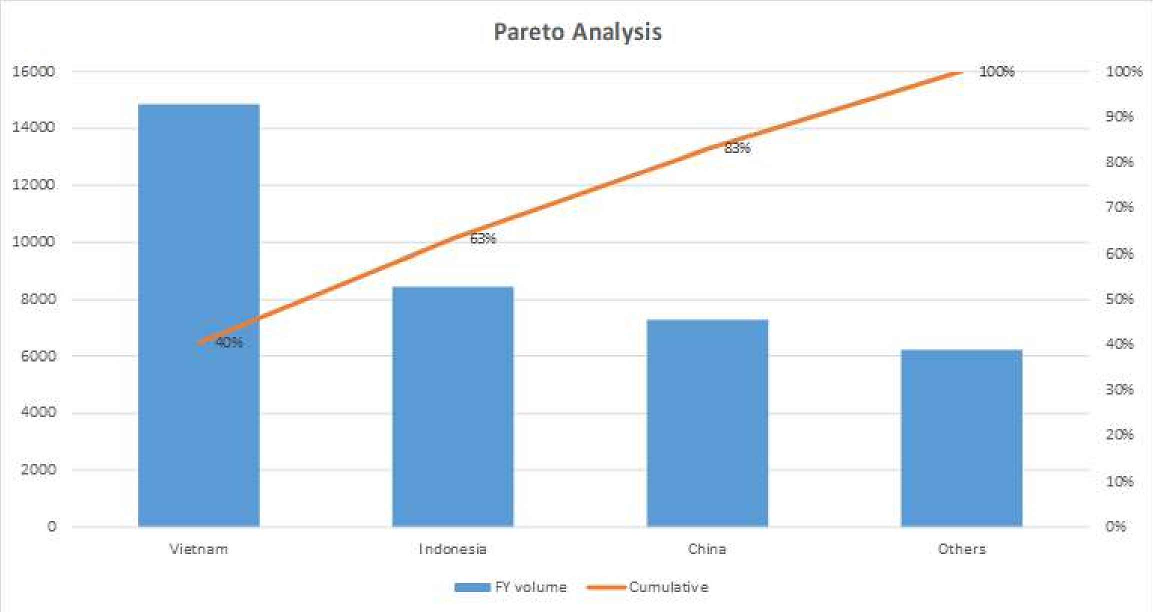
The team is organized into two main pillars, according to the respective flows: DC and DRS. From a bottom-up point of view, the hierarchies go from **Interns** and **Interim**, passing through the **Specialists** who are more dedicated to day-to-day operations. The next role is covered by **Analysts**, that mainly work on mid/long term projects. Every team is managed and led by their **Leads**, who take care of all the issues that may arise from a team and coordinate it. At the top, there are two **Managers** who mainly act on a strategical level. The head of the team is then represented by the **Director**.

Appendix 4: Wings' track entrance at ELC

Recycled pathway Wings DC. Source: ELC Communication

Example of the pathway used by the employees to get into the Wings DC, made out of recycled material (Nike, Sharepoint Communication, 2018).

Appendix 5: Main origins



Pareto Analysis for Nike's origins. Source: Nike Inbound Data

A Pareto analysis has been realized to get an overview of where Nike ELC mainly gets its products from. As the figure above shows, there are 19 countries in total that serve the entire ELC flow by maritime transportation, reaching either the ports of Antwerp/Rotterdam or the UK Ports. Among these, China, Indonesia, and Vietnam - that represent the 16% of the previously mentioned countries - cover, based on the expected volume that will be shipped in the FY20, the 83% of the total. The figure below depicts how this volume is spread among different origins.

Country	FY volume	%
Vietnam	14865	40%
Indonesia	8447	23%
China	7271	20%
Others	6220	17%

Overview of expected volume per country. Source: Nike Inbound Data

Appendix 6: Costs and CO2 emissions of the different modes of transport

	g CO2/CBM	$/CBM
VL	24.17	16.58-27.92
AF	736.69	325.65
SE	375.71	237.72

Cost and Emissions per mode of transport.

The values for the different means of transport have been retrieved throughout different interviews.

Air freights and vessels include costs for the base rate, fuel surcharges, and security. Since air transport prices are usually expressed per kg, in this case, 1 CBM has been considered equal to 167 kg. For the sea-air solution, it's ~50% less pollutant than air freight and 27% cheaper (Kuijpers, 2018).

Appendix 7: Assumptions list

1) Each carrier has its own vessel type configured in the software, and it changes from the different source locations. As an example, for all the transports from Asia to North Europe, the vehicle key is CCWG_NIKE_DRY6. Hence, for all the carriers, there will be one vessel each for that specific route. Meanwhile, for all the transports from Middle East/India to North Europe, the vehicle key is different from the previous one (CCWG_NIKE_DRY11), hence reflecting in another vehicle for each provider set for this route. The assumption here is that each carrier is assumed to always use a type of vessel with its emission factor for a specific route. This factor has been agreed via the Clean Cargo working group (a company whose aim is to reduce the environmental impact of global goods transportation). Basically, each year, members from the company survey all the LSP's to get info about the emissions they had to finally set an emission factor for each of them. This emission factor is then fed into the software to differentiate each carrier's vessel;
2) Among those 6 carriers, two of them have made a partnership, hence the allocation rate of both of them will be merged in one;
3) LogEC uses the Google Maps' network provided by BearingPoint;
4) The expected volumes for the FY20 are based on forecasts. Therefore, all the calculations behind that will be affected by them (e.g. determination of main origins, rates of allocation among all the carriers).

Appendix 8: Lead Time of the different modes of transport (Ocean, AF, SE)

	Origin Port - Disch. Port/AF Destination	Disch.Port/AF Destination - Inl.Term	Inl.Term/AF Destination - Decon	Inl. Term/AF Destination - Customer	Total
OCEAN	23-34 Days	5 Days	1 Day	1 Day	24-40 Days
AF	5-7 (Standard), 3-4 (Express) Days	1 Day	1-3 Days	1-2 Days	4-10 Days
SE	~15 Days	5 Days	1-3 Days	1-2 Days	21-23 Days

Lead Times per mode of transport. Source: Nike Inbound Data

Similarly to Appendix 6, here the network mapping process has been realized at the beginning of the project throughout different interviews. Different experts from the Inbound team have contributed to fulfill all the information needed to get the different lead times per leg (e.g. Origin Port – Discharging Port = 1 leg).

Appendix 9: List of constraints

1) TOP Lanes: the allocation for each carrier can't exceed 40%;
2) MID Lanes: the allocation for each carrier can't exceed 50%;
3) The maximum total utilization for a single carrier can't exceed 40%;
4) The maximum total utilization for a single alliance can't exceed 50%,
5) The minimum total utilization for a single carrier has to be of the 5%;
6) Totally, the average price per container has to be ≤ $ 1,324.62

All these constraints have been agreed together with the company supervisor of the project and reflect how Nike would feed an optimization tool if it was to be implemented for the allocation process.

Appendix 10: Allocation’s tables

Cost-saving

Origin City	Destination City	FY20 volume	FY20 final LSP 1	FY20 final LSP 2	FY20 final LSP 3	FY20 final LSP 4	FY20 final LSP 5	FY20 allocation LSP 1	FY20 allocation LSP 2	FY20 allocation LSP 3	FY20 allocation LSP 4	FY20 allocation LSP 5		LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
Vietnam	Antwp/Rtrdm/Zbrg	11328	1220	1145	1220	1220	1210		1.00					0	11328	0	0	0
Indonesia	Antwp/Rtrdm/Zbrg	7224	1431	1240	1300	1290	1280		1.00					0	7224	0	0	0
China	Antwp/Rtrdm/Zbrg	2726	1140	1392	1145	1140	1120					1.00		0	0	0	0	2726
China	Antwp/Rtrdm/Zbrg	2230	1130	1375	1850	1130	1120					1.00		0	0	0	0	2230
Vietnam	UK Ports	2041	1220	1195	1240	1220	1210		1.00					0	2041	0	0	0
Vietnam	Antwp/Rtrdm/Zbrg	1363	1431	1260	1200	1260	1210			1.00				0	0	1363	0	0
Cambodia	Antwp/Rtrdm/Zbrg	1215	1911	1590	1895	1640	1620		1.00					0	1215	0	0	0
India	Antwp/Rtrdm/Zbrg	1076	821	1100		1014	1100	1.00						1076	0	0	0	0
Indonesia	UK Ports	1048	1431	1290	1325	1290	1280					1.00		0	0	0	0	1048
Thailand	Antwp/Rtrdm/Zbrg	964	1515	1081	1325	1230	1220		1.00					0	964	0	0	0
China	Antwp/Rtrdm/Zbrg	797	1170	1170	1225	1170	1120					1.00		0	0	0	0	797
China	Antwp/Rtrdm/Zbrg	766	1596	1474	1290	1290	1290			0.33	0.33	0.34		0	0	253	253	260
Pakistan	Antwp/Rtrdm/Zbrg	675	636	940	670	890	900	1.00						675	0	0	0	0
Malaysia	Antwp/Rtrdm/Zbrg	402	1151	1309	1125	1170	1400			1.00				0	0	402	0	0
China	UK Ports	324	1140	1342	1175	1140	1120					1.00		0	0	0	0	324
China	UK Ports	292	1130	1400	1875	1130	1120					1.00		0	0	0	0	292
Cambodia	UK Ports	287	1911	1620	1915	1620	1620		0.33		0.33	0.34		0	95	0	95	98
India	Antwp/Rtrdm/Zbrg	281	721	1140	906	1159	1000	1.00						281	0	0	0	0
China	UK Ports	213	1080	1186	1245	1170	1120	1.00						213	0	0	0	0
Egypt	Antwp/Rtrdm/Zbrg	195			967	1065				1.00				0	0	195	0	0
Sri Lanka	Antwp/Rtrdm/Zbrg	163	850	1459	849	850	850			1.00				0	0	163	0	0
Indonesia	Antwp/Rtrdm/Zbrg	160	1301	1280	1400	1290	1280		0.50			0.50		0	80	0	0	80
Vietnam	UK Ports	133	1431	1310	1210	1290	1210			0.50		0.50		0	0	67	0	67
Pakistan	UK Ports	122	671	1030	705	1130	900	1.00						122	0	0	0	0
India	UK Ports	102	821	1260		982	1100	1.00						102	0	0	0	0
China	UK Ports	97	1596	1474	1300	1320	1290					1.00		0	0	0	0	97
Jordan	Antwp/Rtrdm/Zbrg	77	1511	1552	1116	1560				1.00				0	0	77	0	0
China	UK Ports	77	1586	1131	1340	1260	1220		1.00					0	77	0	0	0
Malaysia	UK Ports	66	1151	1410	1145	1170	1400			1.00				0	0	66	0	0
Taiwan	Antwp/Rtrdm/Zbrg	52	1171			1290	1260	1.00						52	0	0	0	0
Egypt	UK Ports	43			984	1065				1.00				0	0	43	0	0
Sri Lanka	UK Ports	39	1051	1459	884	860	850					1.00		0	0	0	0	39
Honduras	Antwp/Rtrdm/Zbrg	27	564	1400	2378	4071		1.00						27	0	0	0	0
USA	Antwp/Rtrdm/Zbrg	22	1066	1505	3092	443	1150				1.00			0	0	0	22	0
Guatemala	Antwp/Rtrdm/Zbrg	19	658	1600	1735	4326		1.00						19	0	0	0	0
El Salvador	Antwp/Rtrdm/Zbrg	19	988	1880	2250	3501		1.00						19	0	0	0	0
Indonesia	UK Ports	15	1301	1320	1425	1320	1280					1.00		0	0	0	0	15
Mexico	Antwp/Rtrdm/Zbrg	14		1312	1093	3284	5500			1.00				0	0	14	0	0
Guatemala	Antwp/Rtrdm/Zbrg	13	2394	1151	2425	4326			1.00					0	13	0	0	0
USA	Antwp/Rtrdm/Zbrg	12	526	983	1185	473	150					1.00		0	0	0	0	12
Singapore	Antwp/Rtrdm/Zbrg	11	1351	1248	1415	1160	1120					1.00		0	0	0	0	11
Mexico	Antwp/Rtrdm/Zbrg	10	1239	1464	1800	3284	8525	1.00						10	0	0	0	0
Malaysia	Antwp/Rtrdm/Zbrg	10	1301	1400	1200	1400	1260			1.00				0	0	10	0	0
Jordan	UK Ports	8	2161	1552	1151	1535				1.00				0	0	8	0	0
Taiwan	UK Ports	8	1171			1290	1260	1.00						8	0	0	0	0
USA	UK Ports	4	1936	1505	3227	672	1150				1.00			0	0	0	4	0
Mexico	Antwp/Rtrdm/Zbrg	4	688	1162	1046	3284		1.00						4	0	0	0	0
Guatemala	UK Ports	4	1481	1600	1770	4295		1.00						4	0	0	0	0
El Salvador	UK Ports	4	1811	1880	2335	3470		1.00						4	0	0	0	0
Honduras	UK Ports	4	1364	1339	1963	4040			1.00					0	4	0	0	0
Mexico	UK Ports	2	2576		1935	3253	8800		1.00					0	2	0	0	0
USA	Antwp/Rtrdm/Zbrg	2	905	1210	1668	443	900				1.00			0	0	0	2	0
USA	Antwp/Rtrdm/Zbrg	2	131		375	473	150					1.00		0	0	0	0	2
USA	Antwp/Rtrdm/Zbrg	2	1181		1325	2608	1400	1.00						2	0	0	0	0
Malaysia	UK Ports	2	1301	1310	1225	1400	1260			1.00				0	0	2	0	0
Israel	Antwp/Rtrdm/Zbrg	2			1015	950					1.00			0	0	0	2	0
Singapore	UK Ports	2	1347	1336	1440	1160	1120					1.00		0	0	0	0	2
USA	UK Ports	1	2055	1210	1803	672	900				1.00			0	0	0	1	0
Mexico	UK Ports	1	2025		1181	3253			1.00				36803	0	1	0	0	0
Israel	UK Ports	1			1030	950					1.00			0	0	0	1	0
													FY20 volume/LSP	2618	23044	2662	379	8100
													%	0.07	0.63	0.07	0.01	0.22

Time-saving

Origin City	Destination City	FY20 volume	LT LSP 1	LT LSP 2	LT LSP 3	LT LSP 4	LT LSP 5	FY20 allocation LSP 1	FY20 allocation LSP 2	FY20 allocation LSP 3	FY20 allocation LSP 4	FY20 allocation LSP 5		LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
Vietnam	Antwp/Rtrdm/Zbrg	11328	30	26	29	28	25					1.00		0	0	0	0	11328
Indonesia	Antwp/Rtrdm/Zbrg	7224	29	26	30	32	27		1.00					0	7224	0	0	0
China	Antwp/Rtrdm/Zbrg	2726	24	23	26	27	23		0.50			0.50		0	1363	0	0	1363
China	Antwp/Rtrdm/Zbrg	2230	30	25	29	31	28		1.00					0	2230	0	0	0
Vietnam	UK Ports	2041	28	34	26	26	26			0.30	0.35	0.35		0	0	612	714	714
Vietnam	Antwp/Rtrdm/Zbrg	1363	41	32	32	34	31					1.00		0	0	0	0	1363
Cambodia	Antwp/Rtrdm/Zbrg	1215	27	28	33	30	28	1.00						1215	0	0	0	0
India	Antwp/Rtrdm/Zbrg	1076	20	29	29	25	24	1.00						1076	0	0	0	0
Indonesia	UK Ports	1048	24	31	28	29	24	0.50				0.50		524	0	0	0	524
Thailand	Antwp/Rtrdm/Zbrg	964	30	27	32	30	29		1.00					0	964	0	0	0
China	Antwp/Rtrdm/Zbrg	797	32	43	38	37	41	1.00						797	0	0	0	0
China	Antwp/Rtrdm/Zbrg	766	30	33	37	39	33	1.00						766	0	0	0	0
Pakistan	Antwp/Rtrdm/Zbrg	675	27	25	27	22	25				1.00			0	0	0	675	0
Malaysia	Antwp/Rtrdm/Zbrg	402	18	26	20	22	23	1.00						402	0	0	0	0
China	UK Ports	324	25	25	26	27	26	0.50	0.50					162	162	0	0	0
China	UK Ports	292	28	31	31	30	30	1.00						292	0	0	0	0
Cambodia	UK Ports	287	23	35	38	27	36	1.00						287	0	0	0	0
India	Antwp/Rtrdm/Zbrg	281	27	26	30	24	34				1.00			0	0	0	281	0
China	UK Ports	213	34	33	35	36	33		0.50			0.50		0	107	0	0	107
Egypt	Antwp/Rtrdm/Zbrg	195			17	25				1.00				0	0	195	0	0
Sri Lanka	Antwp/Rtrdm/Zbrg	163	18	23	21	19	17					1.00		0	0	0	0	163
Indonesia	Antwp/Rtrdm/Zbrg	160	30	31	31	34	30	0.50				0.50		80	0	0	0	80
Vietnam	UK Ports	133	28	38	30	35	34	1.00						133	0	0	0	0
Pakistan	UK Ports	122	26	27	13	20	30			1.00				0	0	122	0	0
India	UK Ports	102	32	29		21	32				1.00			0	0	0	102	0
China	UK Ports	97	31	42	35	36	44	1.00						97	0	0	0	0
Jordan	Antwp/Rtrdm/Zbrg	77	17	26	25	18		1.00						77	0	0	0	0
Thailand	UK Ports	77	35	35	30	28	37				1.00			0	0	0	77	0
Malaysia	UK Ports	66	28	26	20	22	23			1.00				0	0	66	0	0
Taiwan	Antwp/Rtrdm/Zbrg	52	27			28	26					1.00		0	0	0	0	52
Egypt	UK Ports	43			16	9					1.00			0	0	0	43	0
Sri Lanka	UK Ports	39	19	25	17	16	27				1.00			0	0	0	39	0
Honduras	Antwp/Rtrdm/Zbrg	27	18	21	31	25		1.00						27	0	0	0	0
USA	Antwp/Rtrdm/Zbrg	22	14	18	9	10	19			1.00				0	0	22	0	0
Guatemala	Antwp/Rtrdm/Zbrg	19	25	19	31	25			1.00					0	19	0	0	0
El Salvador	Antwp/Rtrdm/Zbrg	19	25	22	24	24			1.00					0	19	0	0	0
Indonesia	UK Ports	15	25	29	29	32	26	1.00						15	0	0	0	0
Mexico	Antwp/Rtrdm/Zbrg	14		34	25	24	32				1.00			0	0	0	14	0
Guatemala	Antwp/Rtrdm/Zbrg	13	21	35	26	24		1.00						13	0	0	0	0
USA	Antwp/Rtrdm/Zbrg	12	20	16	12	13	16			1.00				0	0	12	0	0
Singapore	Antwp/Rtrdm/Zbrg	11	21	20	29	23	20		0.50			0.50		0	6	0	0	6
Mexico	Antwp/Rtrdm/Zbrg	10	20	46	38	21	29	1.00						10	0	0	0	0
Malaysia	Antwp/Rtrdm/Zbrg	10	25	27	32	28	27	1.00						10	0	0	0	0
Jordan	UK Ports	8	19	25	18	19				1.00				0	0	8	0	0
Taiwan	UK Ports	8	28			34	37	1.00						8	0	0	0	0
USA	UK Ports	4	23	19	18	17	18				1.00			0	0	0	4	0
Mexico	Antwp/Rtrdm/Zbrg	4	22	39	25	24		1.00						4	0	0	0	0
Guatemala	UK Ports	4	24	39	32	30		1.00						4	0	0	0	0
El Salvador	UK Ports	4	24	39	31	29		1.00						4	0	0	0	0
Honduras	UK Ports	4	23	39	31	30		1.00						4	0	0	0	0
Mexico	UK Ports	2	24	46	32	28	27	1.00						2	0	0	0	0
USA	Antwp/Rtrdm/Zbrg	2	19	18	14	17	17			1.00				0	0	2	0	0
USA	Antwp/Rtrdm/Zbrg	2	20		12	13	13			1.00				0	0	2	0	0
USA	Antwp/Rtrdm/Zbrg	2	35		38	21	35				1.00			0	0	0	2	0
Malaysia	UK Ports	2	28	35	30	33	25					1.00		0	0	0	0	2
Israel	Antwp/Rtrdm/Zbrg	2			17					1.00				0	0	2	0	0
Singapore	UK Ports	2	21	22	28	29	22	1.00						2	0	0	0	0
USA	UK Ports	1	23	15	14	15	18			1.00				0	0	1	0	0
Mexico	UK Ports	1	26		24	30				1.00			36803	0	0	1	0	0
Israel	UK Ports	1			12					1.00				0	0	1	0	0
													FY20 volume/LSP	6011	12093	1046	1951	15701
													%	0.16	0.33	0.03	0.05	0.43

Eco-friendly

Origin City	Destination City	FY20 volume	CO2e TEU-km LSP 1	CO2e TEU-km LSP 2	CO2e TEU-km LSP 3	CO2e TEU-km LSP 4	CO2e TEU-km LSP 5	FY20 allocation LSP 1	FY20 allocation LSP 2	FY20 allocation LSP 3	FY20 allocation LSP 4	FY20 allocation LSP 5		LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
Vietnam	Antwp/Rtrdm/Zbrg	11328	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	11328	0
Indonesia	Antwp/Rtrdm/Zbrg	7224	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	7224	0
China	Antwp/Rtrdm/Zbrg	2726	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	2726	0
China	Antwp/Rtrdm/Zbrg	2230	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	2230	0
Vietnam	UK Ports	2041	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	2041	0
Vietnam	Antwp/Rtrdm/Zbrg	1363	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	1363	0
Cambodia	Antwp/Rtrdm/Zbrg	1215	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	1215	0
India	Antwp/Rtrdm/Zbrg	1076	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	1076
Indonesia	UK Ports	1048	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	1048	0
Thailand	Antwp/Rtrdm/Zbrg	964	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	964	0
China	Antwp/Rtrdm/Zbrg	797	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	797	0
China	Antwp/Rtrdm/Zbrg	766	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	766	0
Pakistan	Antwp/Rtrdm/Zbrg	675	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	675
Malaysia	Antwp/Rtrdm/Zbrg	402	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	402	0
China	UK Ports	324	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	324	0
China	UK Ports	292	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	292	0
Cambodia	UK Ports	287	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	287	0
India	Antwp/Rtrdm/Zbrg	281	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	281
China	UK Ports	213	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	213	0
Egypt	Antwp/Rtrdm/Zbrg	195	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	195
Sri Lanka	Antwp/Rtrdm/Zbrg	163	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	163
Indonesia	Antwp/Rtrdm/Zbrg	160	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	160	0
Vietnam	UK Ports	133	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	133	0
Pakistan	UK Ports	122	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	122
India	UK Ports	102	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	102
China	UK Ports	97	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	97	0
Jordan	Antwp/Rtrdm/Zbrg	77	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	77
China	UK Ports	77	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	77	0
Malaysia	UK Ports	66	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	66	0
Taiwan	Antwp/Rtrdm/Zbrg	52	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	52	0
Egypt	UK Ports	43	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	43
Sri Lanka	UK Ports	39	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	39
Honduras	Antwp/Rtrdm/Zbrg	27	130.30	60.98	68.85	69.07			1.00					0	27	0	0	0
USA	Antwp/Rtrdm/Zbrg	22	104.75	92.30	65.10	93.55	92.61			1.00				0	0	22	0	0
Guatemala	Antwp/Rtrdm/Zbrg	19	130.30	60.98	68.85	69.07			1.00					0	19	0	0	0
El Salvador	Antwp/Rtrdm/Zbrg	19	130.30	60.98	68.85	69.07			1.00					0	19	0	0	0
Indonesia	UK Ports	15	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	15	0
Mexico	Antwp/Rtrdm/Zbrg	14	130.30	60.98	68.85	69.07			1.00					0	14	0	0	0
Guatemala	Antwp/Rtrdm/Zbrg	13	130.30	60.98	68.85	69.07			1.00					0	13	0	0	0
USA	Antwp/Rtrdm/Zbrg	12	104.75	92.30	65.10	93.55	92.61			1.00				0	0	12	0	0
Singapore	Antwp/Rtrdm/Zbrg	11	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	11	0
Mexico	Antwp/Rtrdm/Zbrg	10	130.30	60.98	68.85	69.07			1.00					0	10	0	0	0
Malaysia	Antwp/Rtrdm/Zbrg	10	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	10	0
Jordan	UK Ports	8	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	8
Taiwan	UK Ports	8	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	8	0
USA	UK Ports	4	104.75	92.30	65.10	93.55	92.61			1.00				0	0	4	0	0
Mexico	Antwp/Rtrdm/Zbrg	4	130.30	60.98	68.85	69.07			1.00					0	4	0	0	0
Guatemala	UK Ports	4	130.30	60.98	68.85	69.07			1.00					0	4	0	0	0
El Salvador	UK Ports	4	130.30	60.98	68.85	69.07			1.00					0	4	0	0	0
Honduras	UK Ports	4	130.30	60.98	68.85	69.07			1.00					0	4	0	0	0
Mexico	UK Ports	2	130.30	60.98	68.85	69.07			1.00					0	2	0	0	0
USA	Antwp/Rtrdm/Zbrg	2	104.75	92.30	65.10	93.55	92.61			1.00				0	0	2	0	0
USA	Antwp/Rtrdm/Zbrg	2	104.75	92.30	65.10	93.55	92.61			1.00				0	0	2	0	0
USA	Antwp/Rtrdm/Zbrg	2			67.08	68.46				1.00				0	0	2	0	0
Malaysia	UK Ports	2	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	2	0
Israel	Antwp/Rtrdm/Zbrg	2	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	2
Singapore	UK Ports	2	46.79	43.72	51.35	38.41	46.84				1.00			0	0	0	2	0
USA	UK Ports	1	104.75	92.30	65.10	93.55	92.61			1.00				0	0	1	0	0
Mexico	UK Ports	1	130.30	60.98	68.85	69.07			1.00				36803	0	1	0	0	0
Israel	UK Ports	1	60.81	65.72	64.05	53.77	31.68					1.00		0	0	0	0	1
													FY20 volume/LSP	0	121	45	33853	2784
													%	-	0.00	0.00	0.92	0.08

AS-IS

Origin City	Destination City	FY20 volume	FY20 final LSP 1	FY20 final LSP 2	FY20 final LSP 3	FY20 final LSP 4	FY20 final LSP 5	FY20 allocation LSP 1	FY20 allocation LSP 2	FY20 allocation LSP 3	FY20 allocation LSP 4	FY20 allocation LSP 5		LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
Vietnam	Antwp/Rtrdm/Zbrg	11328	1220	1145	1220	1220	1210	0.32	0.17	0.14	0.13	0.24		3625	1926	1586	1473	2719
Indonesia	Antwp/Rtrdm/Zbrg	7224	1431	1240	1300	1290	1280	0.17	0.23	0.20	0.18	0.22		1228	1662	1445	1300	1589
China	Antwp/Rtrdm/Zbrg	2726	1140	1392	1145	1140	1120	0.48		0.15	0.10	0.27		1308		409	273	736
China	Antwp/Rtrdm/Zbrg	2230	1130	1375	1850	1130	1120	0.30	0.20		0.20	0.30		669	446		446	669
Vietnam	UK Ports	2041	1220	1195	1240	1220	1210	0.20		0.25	0.20	0.35		408		510	408	714
Vietnam	Antwp/Rtrdm/Zbrg	1363	1431	1260	1200	1260	1210	0.40				0.60		545				818
Cambodia	Antwp/Rtrdm/Zbrg	1215	1911	1590	1895	1640	1620	0.30			0.70			365			851	
India	Antwp/Rtrdm/Zbrg	1076	821	1100		1014	1100	0.50			0.50			538			538	
Indonesia	UK Ports	1048	1431	1290	1325	1290	1280	0.25	0.25		0.30	0.20		262	262		314	210
Thailand	Antwp/Rtrdm/Zbrg	964	1515	1081	1325	1230	1220	0.40				0.60		386				578
China	Antwp/Rtrdm/Zbrg	797	1170	1170	1225	1170	1120	0.70			0.30			558			239	
China	Antwp/Rtrdm/Zbrg	766	1596	1474	1290	1290	1290	0.50				0.50		383				383
Pakistan	Antwp/Rtrdm/Zbrg	675	636	940	670	890	900	0.50			0.50			338			338	
Malaysia	Antwp/Rtrdm/Zbrg	402	1151	1309	1125	1170	1400	0.35			0.65			141			261	
China	UK Ports	324	1140	1342	1175	1140	1120	0.20	0.35	0.25	0.20			65	113	81	65	
China	UK Ports	292	1130	1400	1875	1130	1120		0.50		0.50				146		146	
Cambodia	UK Ports	287	1911	1620	1915	1620	1620				1.00						287	
India	Antwp/Rtrdm/Zbrg	281	721	1140	906	1159	1000	0.40			0.60			112			169	
China	UK Ports	213	1080	1186	1245	1170	1120					1.00						213
Egypt	Antwp/Rtrdm/Zbrg	195			967	1065				1.00						195		
Sri Lanka	Antwp/Rtrdm/Zbrg	163	850	1459	849	850	850			0.50		0.50				82		82
Indonesia	Antwp/Rtrdm/Zbrg	160	1301	1280	1400	1290	1280	0.35				0.65		56				104
Vietnam	UK Ports	133	1431	1310	1210	1290	1210					1.00						133
Pakistan	UK Ports	122	671	1030	705	1130	900				1.00						122	
India	UK Ports	102	821	1260		982	1100				1.00						102	
China	UK Ports	97	1596	1474	1300	1320	1290	1.00						97				
Jordan	Antwp/Rtrdm/Zbrg	77	1511	1552	1116	1560				1.00						77		
Thailand	UK Ports	77	1586	1131	1340	1260	1220				1.00						77	
Malaysia	UK Ports	66	1151	1410	1145	1170	1400				1.00						66	
Taiwan	Antwp/Rtrdm/Zbrg	52	1171			1290	1260					1.00						52
Egypt	UK Ports	43			984	1065				1.00						43		
Sri Lanka	UK Ports	39	1051	1459	884	860	850			1.00						39		
Honduras	Antwp/Rtrdm/Zbrg	27	564	1400	2378	4071			0.90		0.10				24		3	
USA	Antwp/Rtrdm/Zbrg	22	1066	1505	3092	443	1150				1.00						22	
Guatemala	Antwp/Rtrdm/Zbrg	19	658	1600	1735	4326			0.90		0.10				17		2	
El Salvador	Antwp/Rtrdm/Zbrg	19	988	1880	2250	3501			0.90		0.10				17		2	
Indonesia	UK Ports	15	1301	1320	1425	1320	1280	1.00						15				
Mexico	Antwp/Rtrdm/Zbrg	14		1312	1093	3284	5500		0.90		0.10				13		1	
Guatemala	Antwp/Rtrdm/Zbrg	13	2394	1151	2425	4326			0.90		0.10				12		1	
USA	Antwp/Rtrdm/Zbrg	12	526	983	1185	473	150				1.00						12	
Singapore	Antwp/Rtrdm/Zbrg	11	1351	1248	1415	1160	1120	1.00						11				
Mexico	Antwp/Rtrdm/Zbrg	10	1239	1464	1800	3284	8525		0.90		0.10				9		1	
Malaysia	Antwp/Rtrdm/Zbrg	10	1301	1400	1200	1400	1260		1.00						10			
Jordan	UK Ports	8	2161	1552	1151	1535				1.00						8		
Taiwan	UK Ports	8	1171			1290	1260					1.00						8
USA	UK Ports	4	1936	1505	3227	672	1150				1.00						4	
Mexico	Antwp/Rtrdm/Zbrg	4	688	1162	1046	3284			0.90		0.10				4			
Guatemala	UK Ports	4	1481	1600	1770	4295			1.00						4			
El Salvador	UK Ports	4	1811	1880	2335	3470			1.00						4			
Honduras	UK Ports	4	1364	1339	1963	4040			1.00						4			
Mexico	UK Ports	2	2576		1935	3253	8800		1.00						2			
USA	Antwp/Rtrdm/Zbrg	2	905	1210	1668	443	900				1.00						2	
USA	Antwp/Rtrdm/Zbrg	2	131		375	473	150				1.00						2	
USA	Antwp/Rtrdm/Zbrg	2	1181		1325	2608	1400				1.00						2	
Malaysia	UK Ports	2	1301	1310	1225	1400	1260					1.00						2
Israel	Antwp/Rtrdm/Zbrg	2			1015	950				1.00						2		
Singapore	UK Ports	2	1347	1336	1440	1160	1120	1.00						2				
USA	UK Ports	1	2055	1210	1803	672	900				1.00						1	
Mexico	UK Ports	1	2025		1181	3253			1.00				36803		1			
Israel	UK Ports	1			1030	950				1.00						1		
													FY20 volume/LSP	11111	4675	4477	7529	9010
													%	0.30	0.13	0.12	0.20	0.24

TO-BE

Origin City	Destination City	FY20 volume	FY20 final LSP 1	FY20 final LSP 2	FY20 final LSP 3	FY20 final LSP 4	FY20 final LSP 5	FY20 allocation LSP 1	FY20 allocation LSP 2	FY20 allocation LSP 3	FY20 allocation LSP 4	FY20 allocation LSP 5		LSP 1	LSP 2	LSP 3	LSP 4	LSP 5		LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
Vietnam	Antwp/Rtrdm/Zbrg	11328	1220	1145	1220	1220	1210	0.20	0.40		0.40			2266	4531	0	4531	0		$ 2,764,032.00	$ 5,188,224.00	$ -	$ 5,528,064.00	$ -
Indonesia	Antwp/Rtrdm/Zbrg	7224	1431	1240	1300	1290	1280	0.20	0.40		0.40			1445	2890	0	2890	0		$ 2,067,508.80	$ 3,583,104.00	$ -	$ 3,727,584.00	$ -
China	Antwp/Rtrdm/Zbrg	2726	1140	1392	1145	1140	1120	0.20	0.40		0.40			545	1090	0	1090	0		$ 621,528.00	$ 1,517,836.80	$ -	$ 1,243,056.00	$ -
China	Antwp/Rtrdm/Zbrg	2230	1130	1375	1850	1130	1120	0.20	0.17		0.40	0.23		446	379	0	892	513		$ 503,980.00	$ 521,743.75	$ -	$ 1,007,960.00	$ 574,056.00
Vietnam	UK Ports	2041	1220	1195	1240	1220	1210	0.20	0.40		0.40			408	816	0	816	0		$ 498,004.00	$ 975,598.00	$ -	$ 996,008.00	$ -
Vietnam	Antwp/Rtrdm/Zbrg	1363	1431	1260	1200	1260	1210	0.20	0.40		0.40			273	545	0	545	0		$ 390,090.60	$ 686,952.00	$ -	$ 686,952.00	$ -
Cambodia	Antwp/Rtrdm/Zbrg	1215	1911	1590	1895	1640	1620	0.20	0.40		0.40			243	486	0	486	0		$ 464,373.00	$ 772,740.00	$ -	$ 797,040.00	$ -
India	Antwp/Rtrdm/Zbrg	1076	821	1100		1014	1100	0.20			0.40	0.40		215	0	0	430	430		$ 176,679.20	$ -	$ -	$ 436,425.60	$ 473,440.00
Indonesia	UK Ports	1048	1431	1290	1325	1290	1280	0.20			0.40	0.40		210	0	0	419	419		$ 299,937.60	$ -	$ -	$ 540,768.00	$ 536,576.00
Thailand	Antwp/Rtrdm/Zbrg	964	1515	1081	1325	1230	1220	0.20	0.40		0.40			193	386	0	386	0		$ 292,092.00	$ 416,833.60	$ -	$ 474,288.00	$ -
China	Antwp/Rtrdm/Zbrg	797	1170	1170	1225	1170	1120			0.50	0.50			0	0	399	399	0		$ -	$ -	$ 488,162.50	$ 466,245.00	$ -
China	Antwp/Rtrdm/Zbrg	766	1596	1474	1290	1290	1290			0.50	0.50			0	0	383	383	0		$ -	$ -	$ 494,070.00	$ 494,070.00	$ -
Pakistan	Antwp/Rtrdm/Zbrg	675	636	940	670	890	900			0.44	0.06	0.50		0	0	300	38	338		$ -	$ -	$ 200,765.50	$ 33,686.50	$ 303,750.00
Malaysia	Antwp/Rtrdm/Zbrg	402	1151	1309	1125	1170	1400			0.50	0.50			0	0	201	201	0		$ -	$ -	$ 226,125.00	$ 235,170.00	$ -
China	UK Ports	324	1140	1342	1175	1140	1120			0.50	0.50			0	0	162	162	0		$ -	$ -	$ 190,350.00	$ 184,680.00	$ -
China	UK Ports	292	1130	1400	1875	1130	1120			0.50	0.50			0	0	146	146	0		$ -	$ -	$ 273,750.00	$ 164,980.00	$ -
Cambodia	UK Ports	287	1911	1620	1915	1620	1620			0.50	0.50			0	0	144	144	0		$ -	$ -	$ 274,802.50	$ 232,470.00	$ -
India	Antwp/Rtrdm/Zbrg	281	721	1140	906	1159	1000				0.50	0.50		0	0	0	141	141		$ -	$ -	$ -	$ 162,839.50	$ 140,500.00
China	UK Ports	213	1080	1186	1245	1170	1120			0.50	0.50			0	0	107	107	0		$ -	$ -	$ 132,592.50	$ 124,605.00	$ -
Egypt	Antwp/Rtrdm/Zbrg	195			967	1065				1.00				0	0	195	0	0		$ -	$ -	$ 188,565.00	$ -	$ -
Sri Lanka	Antwp/Rtrdm/Zbrg	163	850	1459	849	850	850			0.50		0.50		0	0	82	0	82		$ -	$ -	$ 69,193.50	$ -	$ 69,275.00
Indonesia	Antwp/Rtrdm/Zbrg	160	1301	1280	1400	1290	1280	0.35				0.65		56	0	0	0	104		$ 72,856.00	$ -	$ -	$ -	$ 133,120.00
Vietnam	UK Ports	133	1431	1310	1210	1290	1210					1.00		0	0	0	0	133		$ -	$ -	$ -	$ -	$ 160,930.00
Pakistan	UK Ports	122	671	1030	705	1130	900				1.00			0	0	0	122	0		$ -	$ -	$ -	$ 137,860.00	$ -
India	UK Ports	102	821	1260		982	1100				1.00			0	0	0	102	0		$ -	$ -	$ -	$ 100,164.00	$ -
China	UK Ports	97	1596	1474	1300	1320	1290	1.00						97	0	0	0	0		$ 154,812.00	$ -	$ -	$ -	$ -
Jordan	Antwp/Rtrdm/Zbrg	77	1511	1552	1116	1560				1.00				0	0	77	0	0		$ -	$ -	$ 85,932.00	$ -	$ -
Thailand	UK Ports	77	1586	1131	1340	1260	1220				1.00			0	0	0	77	0		$ -	$ -	$ -	$ 97,020.00	$ -
Malaysia	UK Ports	66	1151	1410	1145	1170	1400				1.00			0	0	0	66	0		$ -	$ -	$ -	$ 77,220.00	$ -
Taiwan	Antwp/Rtrdm/Zbrg	52	1171			1290	1260					1.00		0	0	0	0	52		$ -	$ -	$ -	$ -	$ 65,520.00
Egypt	UK Ports	43			984	1065				1.00				0	0	43	0	0		$ -	$ -	$ 42,312.00	$ -	$ -
Sri Lanka	UK Ports	39	1051	1459	884	860	850			1.00				0	0	39	0	0		$ -	$ -	$ 34,476.00	$ -	$ -
Honduras	Antwp/Rtrdm/Zbrg	27	564	1400	2378	4071			0.90		0.10			0	24	0	3	0		$ -	$ 34,020.00	$ -	$ 10,991.70	$ -
USA	Antwp/Rtrdm/Zbrg	22	1066	1505	3092	443	1150				1.00			0	0	0	22	0		$ -	$ -	$ -	$ 9,746.00	$ -
Guatemala	Antwp/Rtrdm/Zbrg	19	658	1600	1735	4326			0.90		0.10			0	17	0	2	0		$ -	$ 27,360.00	$ -	$ 8,219.40	$ -
El Salvador	Antwp/Rtrdm/Zbrg	19	988	1880	2250	3501			0.90		0.10			0	17	0	2	0		$ -	$ 32,148.00	$ -	$ 6,651.90	$ -
Indonesia	UK Ports	15	1301	1320	1425	1320	1280	1.00						15	0	0	0	0		$ 19,515.00	$ -	$ -	$ -	$ -
Mexico	Antwp/Rtrdm/Zbrg	14		1312	1093	3284	5500		0.90		0.10			0	13	0	1	0		$ -	$ 16,531.20	$ -	$ 4,597.60	$ -
Guatemala	Antwp/Rtrdm/Zbrg	13	2394	1151	2425	4326			0.90		0.10			0	12	0	1	0		$ -	$ 13,466.70	$ -	$ 5,623.80	$ -
USA	Antwp/Rtrdm/Zbrg	12	526	983	1185	473	150				1.00			0	0	0	12	0		$ -	$ -	$ -	$ 5,676.00	$ -
Singapore	Antwp/Rtrdm/Zbrg	11	1351	1248	1415	1160	1120	1.00						11	0	0	0	0		$ 14,861.00	$ -	$ -	$ -	$ -
Mexico	Antwp/Rtrdm/Zbrg	10	1239	1464	1800	3284	8525		0.90		0.10			0	9	0	1	0		$ -	$ 13,176.00	$ -	$ 3,284.00	$ -
Malaysia	Antwp/Rtrdm/Zbrg	10	1301	1400	1200	1400	1260		1.00					0	10	0	0	0		$ -	$ 14,000.00	$ -	$ -	$ -
Jordan	UK Ports	8	2161	1552	1151	1535				1.00				0	0	8	0	0		$ -	$ -	$ 9,208.00	$ -	$ -
Taiwan	UK Ports	8	1171			1290	1260					1.00		0	0	0	0	8		$ -	$ -	$ -	$ -	$ 10,080.00
USA	UK Ports	4	1936	1505	3227	672	1150				1.00			0	0	0	4	0		$ -	$ -	$ -	$ 2,688.00	$ -
Mexico	Antwp/Rtrdm/Zbrg	4	688	1162	1046	3284			0.90		0.10			0	4	0	0	0		$ -	$ 4,183.20	$ -	$ -	$ -
Guatemala	UK Ports	4	1481	1600	1770	4295			1.00					0	4	0	0	0		$ -	$ 6,400.00	$ -	$ -	$ -
El Salvador	UK Ports	4	1811	1880	2335	3470			1.00					0	4	0	0	0		$ -	$ 7,520.00	$ -	$ -	$ -
Honduras	UK Ports	4	1364	1339	1963	4040			1.00					0	4	0	0	0		$ -	$ 5,356.00	$ -	$ -	$ -
Mexico	UK Ports	2	2576		1935	3253	8800		1.00					0	2	0	0	0		$ -	$ -	$ -	$ -	$ -
USA	Antwp/Rtrdm/Zbrg	2	905	1210	1668	443	900				1.00			0	0	0	2	0		$ -	$ -	$ -	$ 886.00	$ -
USA	Antwp/Rtrdm/Zbrg	2	131		375	473	150				1.00			0	0	0	2	0		$ -	$ -	$ -	$ 946.00	$ -
USA	Antwp/Rtrdm/Zbrg	2	1181		1325	2608	1400				1.00			0	0	0	2	0		$ -	$ -	$ -	$ 5,216.00	$ -
Malaysia	UK Ports	2	1301	1310	1225	1400	1260					1.00		0	0	0	0	2		$ -	$ -	$ -	$ -	$ 2,520.00
Israel	Antwp/Rtrdm/Zbrg	2			1015	950				1.00				0	0	2	0	0		$ -	$ -	$ 2,030.00	$ -	$ -
Singapore	UK Ports	2	1347	1336	1440	1160	1120	1.00						2	0	0	0	0		$ 2,694.00	$ -	$ -	$ -	$ -
USA	UK Ports	1	2055	1210	1803	672	900				1.00			0	0	0	1	0		$ -	$ -	$ -	$ 672.00	$ -
Mexico	UK Ports	1	2025	1162	1181	3253			1.00				36803	0	1	0	0	0		$ -	$ 1,162.00	$ -	$ -	$ -
Israel	UK Ports	1			1030	950				1.00				0	0	1	0	0		$ -	$ -	$ 1,030.00	$ -	$ -
												FY20 volume/LSP	6424	11244	2287	#####	2221	Average cost/container	$ 1,298.72	$ 1,230.71	$ 1,186.61	$ 1,231.54	$1,112.18
												%	0.17	0.31	0.06	0.40	0.06	Total average			$ 1,211.95		

Appendix 11: New allocation process template

BIG-MID lanes

			ALLOCATION						UTILIZATION				
Origin City	Destination City	FY20 volume	FY20 allocation LSP 1	FY20 allocation LSP 2	FY20 allocation LSP 3	FY20 allocation LSP 4	FY20 allocation LSP 5	Sum of allocations	LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
Vietnam	Antwp/Rtrdm/Zbrg	11328	0.20	0.40		0.40		1.00	2265.60	4531.20	0.00	4531.20	0.00
Indonesia	Antwp/Rtrdm/Zbrg	7224	0.20	0.40		0.40		1.00	1444.80	2889.60		2889.60	
China	Antwp/Rtrdm/Zbrg	2726	0.20	0.40		0.40		1.00	545.20	1090.40	0.00	1090.40	0.00
China	Antwp/Rtrdm/Zbrg	2230	0.20	0.17		0.40	0.23	1.00	446.00	379.45		892.00	512.55
Vietnam	UK Ports	2041	0.20	0.40		0.40		1.00	408.20	816.40	0.00	816.40	0.00
Vietnam	Antwp/Rtrdm/Zbrg	1363	0.20	0.40		0.40		1.00	272.60	545.20		545.20	
Cambodia	Antwp/Rtrdm/Zbrg	1215	0.20	0.40		0.40		1.00	243.00	486.00	0.00	486.00	0.00
India	Antwp/Rtrdm/Zbrg	1076	0.20			0.40	0.40	1.00	215.20			430.40	430.40
Indonesia	UK Ports	1048	0.20			0.40	0.40	1.00	209.60	0.00	0.00	419.20	419.20
Thailand	Antwp/Rtrdm/Zbrg	964	0.20	0.40		0.40		1.00	192.80	385.60		385.60	
China	Antwp/Rtrdm/Zbrg	797			0.50	0.50		1.00	0.00	0.00	398.50	398.50	0.00
China	Antwp/Rtrdm/Zbrg	766			0.50	0.50		1.00			383.00	383.00	
Pakistan	Antwp/Rtrdm/Zbrg	675			0.44	0.06	0.50	1.00	0.00	0.00	299.65	37.85	337.50
Malaysia	Antwp/Rtrdm/Zbrg	402			0.50	0.50		1.00			201.00	201.00	
China	UK Ports	324			0.50	0.50		1.00	0.00	0.00	162.00	162.00	0.00
China	UK Ports	292			0.50	0.50		1.00			146.00	146.00	
Cambodia	UK Ports	287			0.50	0.50		1.00	0.00	0.00	143.50	143.50	0.00
India	Antwp/Rtrdm/Zbrg	281			0.00	0.50	0.50	1.00			0.00	140.50	140.50
China	UK Ports	213			0.50	0.50		1.00	0.00	0.00	106.50	106.50	0.00

		COSTS									
Origin City	Destination City	FY20 final LSP 1	LSP 1 used?	FY20 final LSP 2	LSP 2 used?	FY20 final LSP 3	LSP 3 used?	FY20 final LSP 4	LSP 4 used?	FY20 final LSP 5	LSP 5 used?
Vietnam	Antwp/Rtrdm/Zbrg	1220	2764032.00	1145	5188224.00	1220	0.00	1220	5528064.00	1210	0.00
Indonesia	Antwp/Rtrdm/Zbrg	1431	2067508.80	1240	3583104.00	1300		1290	3727584.00	1280	
China	Antwp/Rtrdm/Zbrg	1140	621528.00	1392	1517836.80	1145	0.00	1140	1243056.00	1120	0.00
China	Antwp/Rtrdm/Zbrg	1130	503980.00	1375	521743.75	1850		1130	1007960.00	1120	574056.00
Vietnam	UK Ports	1220	498004.00	1195	975598.00	1240	0.00	1220	996008.00	1210	0.00
Vietnam	Antwp/Rtrdm/Zbrg	1431	390090.60	1260	686952.00	1200		1260	686952.00	1210	
Cambodia	Antwp/Rtrdm/Zbrg	1911	464373.00	1590	772740.00	1895	0.00	1640	797040.00	1620	0.00
India	Antwp/Rtrdm/Zbrg	821	176679.20	1100		1100		1014	436425.60	1100	473440.00
Indonesia	UK Ports	1431	299937.60	1290	0.00	1325	0.00	1290	540768.00	1280	536576.00
Thailand	Antwp/Rtrdm/Zbrg	1515	292092.00	1081	416833.60	1325		1230	474288.00	1220	
China	Antwp/Rtrdm/Zbrg	1170	0.00	1170	0.00	1225	488162.50	1170	466245.00	1120	0.00
China	Antwp/Rtrdm/Zbrg	1596		1474		1290	494070.00	1290	494070.00	1290	
Pakistan	Antwp/Rtrdm/Zbrg	636	0.00	940	0.00	670	200765.50	890	33686.50	900	303750.00
Malaysia	Antwp/Rtrdm/Zbrg	1151		1309		1125	226125.00	1170	235170.00	1400	
China	UK Ports	1140	0.00	1342	0.00	1175	190350.00	1140	184680.00	1120	0.00
China	UK Ports	1130		1400		1875	273750.00	1130	164980.00	1120	
Cambodia	UK Ports	1911	0.00	1620	0.00	1915	274802.50	1620	232470.00	1620	0.00
India	Antwp/Rtrdm/Zbrg	721		1140		906	0.00	1159	162839.50	1000	140500.00
China	UK Ports	1080	0.00	1186	0.00	1245	132592.50	1170	124605.00	1120	0.00

BIG-MID volumes	35252
Total volume	36803
% big-mid volumes	0.9578567

	LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
	6243.00	11123.85	1840.15	14204.85	1840.15
Utilization	0.17	0.30	0.05	0.39	0.05

Sum utilizations	0.96

Cost/container LSP 1	1293.97	Cost/container LSP 2	1228.26	Cost/container LSP 3	1239.37	Cost/container LSP 4	1234.57	Cost/container LSP 5	1102.26

Average Cost/container	1219.68

LT										CO2e (WTW) TEU-km [g]					
LT LSP 1	LSP 1 used ?	LT LSP 2	LSP 2 used ?	LT LSP 3	LSP 3 used ?	LT LSP 4	LSP 4 used ?	LT LSP 5	LSP 5 used ?	CO2e LSP 1	CO2e LSP 2	CO2e LSP 3	CO2e LSP 4	CO2e LSP 5	CO2e
30	30.00	26	26.00	29	0.00	28	28.00	25	0.00	46.786	43.716	51.348	38.411	46.84	478132.224
29	29.00	26	26.00	30		32	32.00	27		46.786	43.716	51.348	38.411	46.84	304910.592
24	24.00	23	23.00	26	0.00	27	27.00	23	0.00	46.786	43.716	51.348	38.411	46.84	115059.008
30	30.00	25	25.00	29		31	31.00	28	28.00	46.786	43.716	51.348	38.411	46.84	95725.046
28	28.00	34	34.00	26	0.00	26	26.00	26	0.00	46.786	43.716	51.348	38.411	46.84	86146.528
41	41.00	30	30.00	32		34	34.00	31		46.786	43.716	51.348	38.411	46.84	57529.504
27	27.00	27	27.00	33	0.00	30	30.00	28	0.00	46.786	43.716	51.348	38.411	46.84	51282.720
20	20.00	29		29		25	25.00	24	24.00	60.807	65.721	64.052	53.774	31.678	49864.2072
24	24.00	31	0.00	28	0.00	29	29.00	24	24.00	46.786	43.716	51.348	38.411	46.84	45543.565
30	30.00	27	27.00	32		30	30.00	29		46.786	43.716	51.348	38.411	46.84	40688.512
32	0.00	43	0.00	38	38.00	37	37.00	41	0.00	46.786	43.716	51.348	38.411	46.84	35768.962
36		33		37	37.00	39	39.00	33		46.786	43.716	51.348	38.411	46.84	34377.697
27	0.00	25	0.00	27	27.00	22	22.00	25	25.00	60.807	65.721	64.052	53.774	31.678	31919.8527
18		26		20	20.00	22	22.00	23		46.786	43.716	51.348	38.411	46.84	18041.559
25	0.00	25	0.00	26	26.00	27	27.00	25	0.00	46.786	43.716	51.348	38.411	46.84	14540.958
30		31		31	31.00	30	30.00	30		46.786	43.716	51.348	38.411	46.84	13104.814
23	0.00	35	0.00	38	38.00	27	27.00	36	0.00	46.786	43.716	51.348	38.411	46.84	12880.417
27		26		30	30.00	32	32.00	34	34.00	60.807	65.721	64.052	53.774	31.678	12006.006
34	0.00	33	0.00	35	35.00	36	36.00	33	0.00	46.786	43.716	51.348	38.411	46.84	9559.334

LT LSP 1	28.30	LT LSP 2	27.25	LT LSP 3	31.33	LT LSP 4	29.68	LT LSP 5	27.00

Average LT	28.71

Total CO2e	1507081.50

SMALL lanes

			ALLOCATION						UTILIZATION				
Origin City	Destination City	FY20 volume	FY20 allocation LSP 1	FY20 allocation LSP 2	FY20 allocation LSP 3	FY20 allocation LSP 4	FY20 allocation LSP 5	Sum of allocations	LSP 1	LSP 2	LSP 3	LSP 4	LSP 5
Egypt	Antwp/Rtrdm/Zbrg	195			1.00			1.00			195.00		
Sri Lanka	Antwp/Rtrdm/Zbrg	163			0.50		0.50	1.00			81.50		81.50
Indonesia	Antwp/Rtrdm/Zbrg	160	0.35				0.65	1.00	56.00				104.00
Vietnam	UK Ports	133					1.00	1.00					133.00
Pakistan	UK Ports	122				1.00		1.00				122.00	
India	UK Ports	102				1.00		1.00				102.00	
China	UK Ports	97	1.00					1.00	97.00				
Jordan	Antwp/Rtrdm/Zbrg	77			1.00			1.00			77.00		
Thailand	UK Ports	77				1.00		1.00				77.00	
Malaysia	UK Ports	66				1.00		1.00				66.00	
Taiwan	Antwp/Rtrdm/Zbrg	52					1.00	1.00					52.00
Egypt	UK Ports	43			1.00			1.00			43.00		
Sri Lanka	UK Ports	39			1.00			1.00			39.00		
Honduras	Antwp/Rtrdm/Zbrg	27		0.90		0.10		1.00		24.30		2.70	
USA	Antwp/Rtrdm/Zbrg	22				1.00		1.00				22.00	
Guatemala	Antwp/Rtrdm/Zbrg	19		0.90		0.10		1.00		17.10		1.90	
El Salvador	Antwp/Rtrdm/Zbrg	19		0.90		0.10		1.00		17.10		1.90	
Indonesia	UK Ports	15	1.00					1.00	15.00				
Mexico	Antwp/Rtrdm/Zbrg	14		0.90		0.10		1.00		12.60		1.40	
Guatemala	Antwp/Rtrdm/Zbrg	13		0.90		0.10		1.00		11.70		1.30	
USA	Antwp/Rtrdm/Zbrg	12				1.00		1.00				12.00	
Singapore	Antwp/Rtrdm/Zbrg	11	1.00					1.00	11.00				
Mexico	Antwp/Rtrdm/Zbrg	10		0.90		0.10		1.00		9.00		1.00	
Malaysia	Antwp/Rtrdm/Zbrg	10		1.00				1.00		10.00			
Jordan	UK Ports	8			1.00			1.00			8.00		
Taiwan	UK Ports	8					1.00	1.00					8.00
USA	UK Ports	4				1.00		1.00				4.00	
Mexico	Antwp/Rtrdm/Zbrg	4		0.90		0.10		1.00		3.60		0.40	
Guatemala	UK Ports	4		1.00				1.00		4.00			
El Salvador	UK Ports	4		1.00				1.00		4.00			
Honduras	UK Ports	4		1.00				1.00		4.00			
Mexico	UK Ports	2		1.00				1.00		2.00			
USA	Antwp/Rtrdm/Zbrg	2				1.00		1.00				2.00	
USA	Antwp/Rtrdm/Zbrg	2				1.00		1.00				2.00	
USA	Antwp/Rtrdm/Zbrg	2				1.00		1.00				2.00	
Malaysia	UK Ports	2					1.00	1.00					2.00
Israel	Antwp/Rtrdm/Zbrg	2			1.00			1.00			2.00		
Singapore	UK Ports	2	1.00					1.00	2.00				
USA	UK Ports	1				1.00		1.00				1.00	
Mexico	UK Ports	1		1.00				1.00		1.00			
Israel	UK Ports	1			1.00			1.00			1.00		
									181.00	120.40	446.50	422.60	380.50
								Utilization	0.00	0.00	0.01	0.01	0.01

	COSTS										
Origin City	Destination City	FY20 final LSP 1	LSP 1 used?	FY20 final LSP 2	LSP 2 used?	FY20 final LSP 3	LSP 3 used?	FY20 final LSP 4	LSP 4 used?	FY20 final LSP 5	LSP 5 used?
Egypt	Antwp/Rtrdm/Zbrg					967	188565.00	1065			
Sri Lanka	Antwp/Rtrdm/Zbrg	850		1459		849	69193.50	850		850	69275.00
Indonesia	Antwp/Rtrdm/Zbrg	1301	72856.00	1280		1400		1290		1280	133120.00
Vietnam	UK Ports	1431		1310		1210		1290		1210	160930.00
Pakistan	UK Ports	671		1030		705		1130	137860.00	900	
India	UK Ports	821		1260				982	100164.00	1100	
China	UK Ports	1596	154812.00	1474		1300		1320		1290	
Jordan	Antwp/Rtrdm/Zbrg	1511		1552		1116	85932.00	1560			
Thailand	UK Ports	1586		1131		1340		1260	97020.00	1220	
Malaysia	UK Ports	1151		1410		1145		1170	77220.00	1400	
Taiwan	Antwp/Rtrdm/Zbrg	1171						1290		1260	65520.00
Egypt	UK Ports					984	42312.00	1065			
Sri Lanka	UK Ports	1051		1459		884	34476.00	860		850	
Honduras	Antwp/Rtrdm/Zbrg	564		1400	34020.00	2378		4071	10991.70		
USA	Antwp/Rtrdm/Zbrg	1066		1505		3092		443	9746.00	1150	
Guatemala	Antwp/Rtrdm/Zbrg	658		1600	27360.00	1735		4326	8219.40		
El Salvador	Antwp/Rtrdm/Zbrg	988		1880	32148.00	2250		3501	6651.90		
Indonesia	UK Ports	1301	19515.00	1320		1425		1320		1280	
Mexico	Antwp/Rtrdm/Zbrg			1312	16531.20	1093		3284	4597.60	5500	
Guatemala	Antwp/Rtrdm/Zbrg	2394		1151	13466.70	2425		4326	5623.80		
USA	Antwp/Rtrdm/Zbrg	526		983		1185		473	5676.00	150	
Singapore	Antwp/Rtrdm/Zbrg	1351	14861.00	1248		1415		1160		1120	
Mexico	Antwp/Rtrdm/Zbrg	1239		1464	13176.00	1800		3284	3284.00	8525	
Malaysia	Antwp/Rtrdm/Zbrg	1301		1400	14000.00	1200		1400		1260	
Jordan	UK Ports	2161		1552		1151	9208.00	1535			
Taiwan	UK Ports	1171						1290		1260	10080.00
USA	UK Ports	1936		1505		3227		672	2688.00	1150	
Mexico	Antwp/Rtrdm/Zbrg	688		1162	4183.20	1046		3284	1313.60		
Guatemala	UK Ports	1481		1600	6400.00	1770		4295			
El Salvador	UK Ports	1811		1880	7520.00	2335		3470			
Honduras	UK Ports	1364		1339	5356.00	1963		4040			
Mexico	UK Ports	2576		1464	2928.00	1935		3253		8800	
USA	Antwp/Rtrdm/Zbrg	905		1210		1668		443	886.00	900	
USA	Antwp/Rtrdm/Zbrg	131				375		473	946.00	150	
USA	Antwp/Rtrdm/Zbrg	1181				1325		2608	5216.00	1400	
Malaysia	UK Ports	1301		1310		1225		1400		1260	2520.00
Israel	Antwp/Rtrdm/Zbrg					1015	2030.00	950			
Singapore	UK Ports	1347	2694.00	1336		1440		1160		1120	
USA	UK Ports	2055		1210		1803		672	672.00	900	
Mexico	UK Ports	2025		1162	1162.00	1181		3253			
Israel	UK Ports					1030	1030.00	950			
		Cost/container LSP 1	1462.64	Cost/container LSP 2	1480.49	Cost/container LSP 3	969.20	Cost/container LSP 4	1132.93	Cost/container LSP 5	1160.17

BIG-MID volumes	1551
Total volume	36803
% small volumes	0.042143304

Sum utilizations	0.04

Average Cost/container	1241.09

LT										CO_2e (WTW) TEU-km [g]					
LT LSP 1	LSP 1 used ?	LT LSP 2	LSP 2 used ?	LT LSP 3	LSP 3 used ?	LT LSP 4	LSP 4 used ?	LT LSP 5	LSP 5 used ?	CO_2e LSP 1	CO_2e LSP 2	CO_2e LSP 3	CO_2e LSP 4	CO_2e LSP 5	CO_2e
				17	17.00							64.052			12490.140
				21	21.00			17	17.00			64.052		31.68	7801.995
30	30.00							30	30.00	46.786				46.84	7491.376
								34	34.00					46.84	6229.720
						20	20.00						53.774		6560.428
						21	21.00						53.774		5484.948
31	31.00							44		46.786				46.84	4538.242
				25	25.00							64.052			4932.004
						28	28.00	37					38.411	46.84	2957.647
						22	22.00						38.411		2535.126
								26	26.00					46.84	2435.680
				16	16.00							64.052			2754.236
				17	17.00							64.052			2498.028
		21	21.00			25	25.00				60.984		69.066		1668.389
						10	10.00						93.546		2058.012
		19	19.00			25	25.00				60.984		69.066		1174.052
		22	22.00			24	24.00				60.984		69.066		1174.052
25	25.00									46.786					701.790
		34	34.00			24	24.00				60.984		69.066		865.091
		35	35.00			24	24.00				60.984		69.066		803.299
						13	13.00						93.546		1122.552
21	21.00									46.786					514.646
		46	46.00			20	20.00				60.984		69.066		617.922
		27	27.00					30	0.00		43.716			46.84	437.160
				18	18.00							64.052			512.416
								37	37.00					46.84	374.720
						17	17.00						93.546		374.184
		39	39.00			24	24.00				60.984		69.066		247.169
		39	39.00								60.984				243.936
		39	39.00								60.984				243.936
		39	39.00								60.984				243.936
										130.297	60.984	68.847	69.066		121.968
						17	17.00						93.546		187.092
						12	12.00						93.546		187.092
						20	20.00						68.464		136.928
								25	25.00					46.84	93.680
				17	17.00							64.052			128.104
21	21.00									46.786					93.572
						15	15.00						93.546		93.546
										130.297	60.984	68.847	69.066		60.984
				12	12.00							64.052			64.052

LT LSP 1	25.60	LT LSP 2	32.73	LT LSP 3	17.88	LT LSP 4	20.06	LT LSP 5	28.17

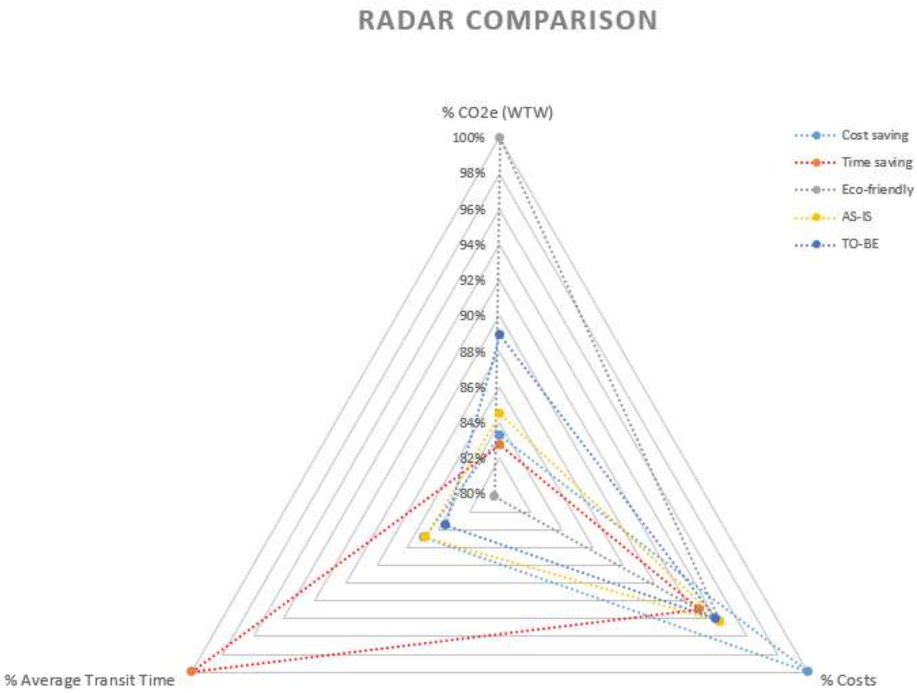
Average LT	24.88

Total CO_2e	83253.85

As the figures above show, the new template presents a broader view on each variable that has to be monitored, hence allowing the user to see how percentages, costs, LT's and emissions change depending on the data set of the solver.

The idea of such a template is to reduce the manual work by limiting it only to the feeding process of the data set of the solver. It also gives higher flexibility towards the monitoring phase of the results as well as a "live" picture on how a specific scenario would impact the analyzed variables.

Appendix 12: Radar comparison



	Cost saving	Time saving	Eco-friendly	AS-IS	TO-BE
% CO2e (WTW)	83%	83%	100%	85%	89%
% Costs	100%	93%	94%	94%	94%
% Average Transit Time	85%	100%	80%	85%	84%

Radar comparison of all the analysed scenarios.

The comparison here shows that among all the scenarios the "TO-BE" is the more balanced, gaining 5% on the "AS-IS" for the $CO2_e$ emissions, hence reducing the gap from the ideal solution to 11%, and losing only 1% on transit time.