BACHELOR THESIS

Implementing third-party logistical warehousing for Flying Fish eFoils

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Flying Fish eFoils B.V. | University of Twente

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Preface

Dear Reader,

You are about to read my bachelor thesis “Implementing third-party logistical warehousing for Flying Fish eFoils”. This research had been conducted at Flying Fish eFoils as the final thesis for my bachelor Industrial Engineering and Management at the University of Twente. My thesis aims for improving the warehousing structure of Flying Fish eFoils, by implementing third-party logistical warehousing. I feel very positive about the process of this research, and I am very satisfied with the conclusion after all these months of work.

First of all, I would like to thank Wouter van Heeswijk, who has fulfilled the role of my first supervisor from the University, for. During my theses, his feedback was always a clear guidance into the right direction. I have learned a lot from his expertise on Industrial Engineering and Management and his methods of doing research. The communication between us always was very comfortable, which was exactly what was needed during this process.

Next, I really want to thank Jochem Koning, my supervisor from Flying Fish eFoils, for creating a platform and an opportunity to perform my research. During my internship in finance and logistics, he has given me a lot of responsibilities from which I learned a lot. During the serious business, there was always time for enjoyable conversations and laughs, which taught me that the working environment at the businesses I will be functioning at throughout my entire career is of great importance. Finally, I would like to thank my family and my friends for their support throughout the process of this research and for keeping me motivated.

Enjoy reading my thesis!

Kind regards,

Dave Broekman
Enschede, September 2022

Management summary

Flying Fish eFoils B.V., known as Flying Fish, is a start-up company which was created in 2019 and is based in Amsterdam. The company mainly focuses on the sales of their e-foil gear. E-foils are battery driven surfboards. Flying Fish eFoils have gotten the exclusive rights from their supplier to sell their product and its equipment over the whole of Europe. In 2021, the company has sold more than 400 e-foils to their customers, which are mainly other businesses. The company strives to provide these boards over the whole of Europe within five days. However, currently more than 60 percent of the orders that Flying Fish sends to their customers does not live up to that promise, with an average lateness of the orders being at 74.5 days.

A company was contacted which was willing to rent a small area of their warehouse to Flying Fish. This company, referred as Warehouse X, has a core activity to buy all sorts of cheap items in bulk and to sell those again to different bargain shops. Due to the fact that the warehousing of Flying Fish is not their core business, Flying Fish eFoils are not a high priority of Warehouse X. The company of Flying Fish have never analysed the performance of their current warehousing functions. This problem causes bad inventory management, which often lead to extended lead times and thus higher risks. As Flying Fish has the target to increase their sales, they need a new warehousing function that is suited for the potential growth. An analysis was done on the current performances and on a potential future situation, in which the following research question is answered:

"How can a third-party logistics warehousing system be organised to decrease the warehousing risks of Flying Fish eFoils?"

During this research an analysis was performed of the current situation of the company. The KPIs such as the average delivery time and the error rate of the company were investigated, which created a reference situation to consider. The costs of the current warehousing are relatively low as a benchmark to other warehouses of the same industry, however, there are no value-added services, which would clarify these costs. In the selection process of a Third-party logistics warehouse there are six dimensions to consider: (1) Quality, (2) Costs, (3) Services, (4) Performances, (5) Information systems and (6) Intangibles. A SMART-type Multi-Criteria Decision-Making tool was created. The tool was sent via a questionnaire to 68 TPL companies throughout the five countries in which Flying Fish has got the most sales via a questionnaire. From the 37 responses, two alternatives were analysed further with in-depth interview. The insights from these interviews can be considered in the tool and be multiplied with the priority coefficient of Flying Fish which were given a normalised weight.

The tool resulted in two different third-party logistics warehouse alternatives, which had a high level of resemblances with the priorities of Flying Fish on how the warehousing structure would ideally be formed. The two alternatives, which are referred to as Warehouse Y and Warehouse Z, have a diversity of value-added services and different costs of their services. After analysing the two different alternatives and comparing them to the current processes at Warehouse X, we can conclude that the optimal warehousing relationship depends on the expected number of sales of Flying Fish in the upcoming years. When the sales increase with the expected fifty percent, Warehouse Y would be optimal for Flying Fish due to their high level of expertise in warehousing of their employees. Although the costs of the company are significantly higher than the current situation, the expertise of the warehouse can help optimising the warehousing management of Flying Fish. This would therefore be the ideal solution for the long term. In a situation in which the sales decrease, Warehouse Z would be the best option for Flying Fish. The lower error rate and the faster delivery time of the services increases the customer satisfaction and therefore increases the loyalty of their customers and enlightens the risks of the supply chain of Flying Fish, hence they can invest their time in increasing the sales. If the sales maintain as in the current situation, research must be done on other alternatives of TPL. The techniques used in this research can function as a framework for the additional research.

Abbreviations

CI	Consistency Index
CR	Consistency Ratio
EPP	Expanded Polypropylene
FFF	Flying Fish eFoils B.V.
KPI	Key Performance Indicator
MCDM	Multi-Criteria Decision-Making
SMART	Simple Multi-Attribute Rating Technique
TPL	Third-Party Logistics

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1. Introduction

In the following chapter, our research for the company Flying Fish Foils is introduced. In Section 1.1 we introduce the company itself, after which the motivation for our assignment follows in Section 1.2. From the assignment we derive a core problem Section 1.3 and its research goal in Section 1.4. After this in Section 1.5, we depict the full design of the research consisting of the research questions, which are needed for the problem-solving element of this assignment.

1.1 Company description

In this section, the important background information of the company is explained. The goal of this section is to create insight and understanding in what the company's core business activities are, so that we can create a clear view for the research.

1.1.1 Flying Fish eFoils

In this first section, we are going over the company of Flying Fish eFoils, often referred to as Flying Fish, themselves. This company is the main stakeholder in this research, as this research is applied to their business. To be able to investigate more on the matter, we describe the company. Flying Fish Foils is a start-up which was created in 2019 and is based in Amsterdam. It currently exists out of nine employees, who are working on all sorts of areas for the company. The company is mainly focussing on two different areas of water sports: Teaching surf classes to customers and selling gear for e-foils. The company currently has got six franchise offices throughout the whole of Netherlands in which customers can book a lesson to try all sorts of surfing. In this segment of the company, a lot of focus is laid upon the business-to-business marketing, in which company events are the main goal.

In addition to their franchise offices, the company is focussing on selling the gear for e-foils. A foil is a vertical wing which is placed underneath a surfboard, which makes it possible to float fifty centimetres above the water with the board, due to friction. E-foiling is a type of foiling, in which a battery-driven propellor creates speeds up to 35 km/h. Flying Fish eFoils (FFF) currently sells the boards and its equipment over the whole of Europe. There are four different types of boards and more than 20 different smaller parts which are needed in case of reliability issues. In 2021, the company has sold more than 400 e-foils to customers. The customer base of the company mainly exists out of water sport centres, which then sell the products to individuals themselves. The company strives to provide these boards over the whole of Europe within five days. The objective in the upcoming year is to double the number of boards that they have sold.

Our research covers the part of the company that sells the gear for e-foiling. The e-foiling boards are produced in China by a company named Waydoo, after which they are shipped to the warehouse of the Flying Fish eFoils in Wieringerwerf in the Netherlands. FFF has the exclusive rights to sell the product and its equipment over the whole of Europe. The ambition of Flying Fish is to introduce the new modern outdoor sport to the world and to make it accessible by selling top of the class e-foil gear. If possible, FFF wants to develop the numbers of sales and customers with fifty percent in 2022. Flying Fish wants to distinguish itself by providing the lowest prices in the market and by providing personal services towards each customer. The company focuses on being cost-efficient in their products and in their services.

1.1.2 Warehouse X

As this research is about improving the logistics and warehousing at the company Flying Fish eFoils, we elaborate more about the current warehouse that they use. Knowledge about the background of the current warehouse of Flying Fish supports understanding where the possible issues lay.

In the current situation, Flying Fish eFoils do not have their own warehouse. The product that Flying Fish is selling, is large in size, which requires a big warehouse. As the company has only existed for

two years, Flying Fish does not have the financial situation for having their own big warehouse. Via an acquaintance of Flying Fish eFoils, a company was contacted which was willing to rent a small area of their warehouse to Flying Fish. This company is referred to as Warehouse X.

Flying Fish eFoils uses Warehouse X as a storage of all the gear that they want to sell. Warehouse X was first based in Akersloot, which was a 20-minute drive from the office of Flying Fish eFoils in Amsterdam. However, since February 2021 Warehouse X has moved to Wieringerwerf, which is about a 50-minute drive from the office. The total area of the warehouse currently equals 18,000 squared metres, from which Flying Fish is only renting approximately 500 squared metres. Warehouse X's core activity is to buy all sorts of cheap items in bulk and to sell them again to different bargain shops. For this purpose, Warehouse X has a big warehouse in which Flying Fish eFoils is rents a relatively small space to stock their gear. Flying Fish currently is the only party which is renting space from Warehouse X.

1.2 Research motivation

In this section, we are elaborating on the motivation of Flying Fish eFoils to start this research. The objective is to create more knowledge about how the company has come to the idea of this research, and why they are anticipating adjusting their current warehousing system.

As a start-up, Flying Fish have entered a fast-growing market. The company mainly imports electrical surfboards from manufacturers in China, after which they distribute them throughout the whole of Europe. Connecting the manufacturers and the customers is thus a big part of their operations. For this purpose, the logistical section of the company have to function efficiently. The fact that the company wants to be able to deliver their product to each customer within a timespan of five days, raises the importance and the risks of the logistics even more. The risks of the logistics can be found in the lack of security procedures, liability for loss or delays and mostly in a lack of inventory. Currently these risks are the cause that more than 60 percent of the orders that Flying Fish sends to their customer, does not live up to that promise. The current delivery times are shown in Figure 1, which underlines the urgency of our research. As visible, 25 percent of the orders have a delivery time higher than 72 days.

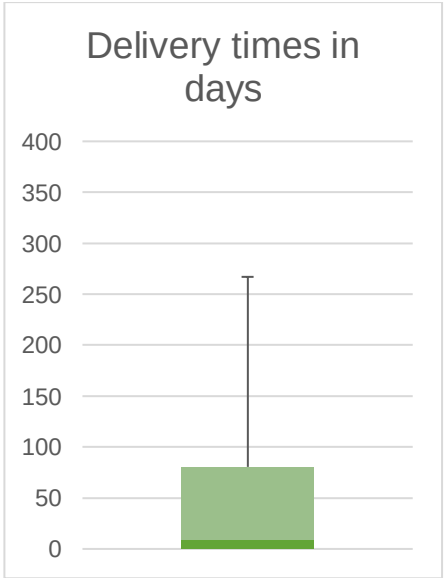

FIGURE 1 DELIVERY TIMES OF FLYING FISH EFOILS

During the first two years of the start-up phase of Flying Fish, Warehouse X was sufficient for the services that the company wanted to provide. However, the company is working for a growth in the

market, in which they constantly need to deal with higher expectations from the customer, for example in terms of the reliability of services and the delivery times. As the number of customers increases, the number of hours to put in activities like aftercare and the product marketing increases together with it. This is due to the fact that the company distributes a better-known product in the market, which has the effect that mistakes have stronger negative influences on the company. Consequently, maintaining their own promises keeps getting more difficult, as the sales grow.

In the current situation, the warehousing system with Warehouse X does not seem to suffice for possible growth into the future. As mentioned in Section 1.1.2, Warehouse X have their own core activities for their market. The warehouse is thus not focused on their warehousing activities for other companies, but mainly for the warehousing activities for themselves. This is why they do have little experience in being a warehouse for other parties. Due to this, all sorts of problems due to miscommunications and different priorities are occurring.

Examples of the problems that are currently occurring are mistakes in picking the order, which have the result that the customers do not receive what they have ordered. The fact that Flying Fish does not have insights into their stock levels, is among other reasons due to the fact that Warehouse X does not precisely keep track of what they sent out. Due to the fact that Warehouse X has different priorities than Flying Fish, the timing of picking an order often is not ideal for one of the parties. This leads to increased delivery times, which is not beneficial for the image of the company. The different priorities between Flying Fish and Warehouse X cause that the employees of Flying Fish often have to go to the warehouse, to make sure everything is taken care of. The process of the employees having to resolve the mistakes that Warehouse X has made becomes inefficient due to the difficult accessibility.

As mentioned, the logistical section of Flying Fish is an important part in distinguishing themselves from the market and to stay competitive. Flying Fish has the promise to deliver the product within five days to the customer. However, due to some errors and uncertainties in communication and the different priorities of the two parties, in more than 60% of the orders this is not the case. Therefore, this is a problem that needs to be solved for Flying Fish.

1.3 Problem identification

In this section, we focus on establishing the causal links of the problems that are prevalent in this company. Multiple causes are the origin of problems, which means that a problem cluster makes a clear overview of these problems.

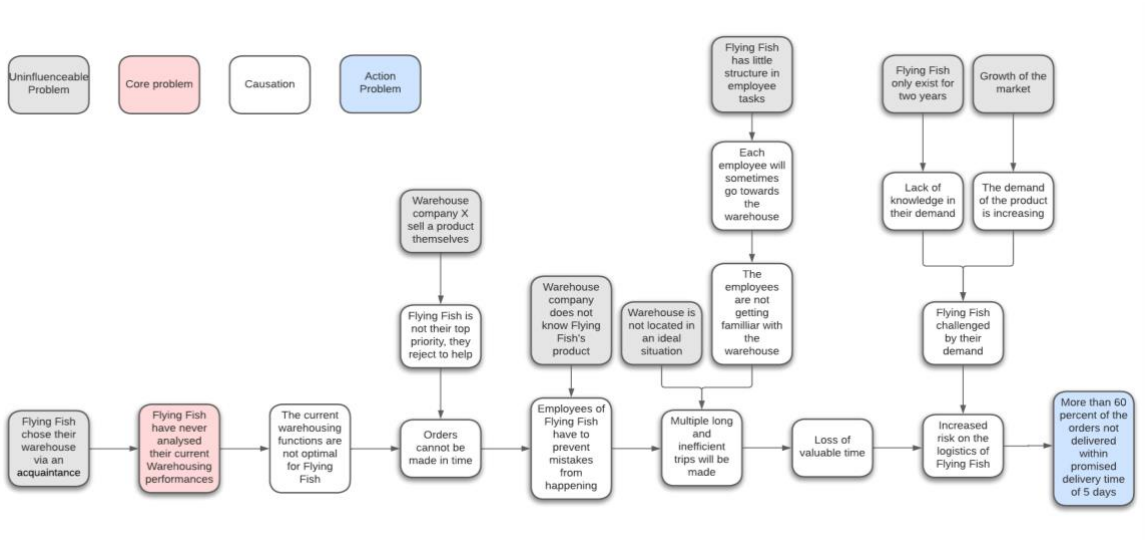

FIGURE 2 PROBLEM CLUSTER OF FLYING FISH EFOILS

The problem cluster describes current problems at the company, and the relationship between them. Figure 2 depicts the structure of problems that are made with regards to the current warehousing system.

The first uninfluenceable problem is the fact that, as described in Section 1.1.2, Flying Fish have only chosen this warehouse via an acquaintance. This indicates that not a lot of attention went into the decision process of the warehousing system of the company. This decision was based on the processes at the start of the Flying Fish' operations, Flying Fish have never analysed their warehousing performances ever since. In Section 1.1.2, we mentioned that Warehouse X chooses to focus on their core activities. The warehouse buys cheap items in bulk, to sell them in the markets they operate in. Since they want to keep this as profitable as possible, they are not solely focused on the company of Flying Fish. This means that they do not have an expertise as being a warehouse, which means that not all operations run as efficiently as possible. This leads to a lot of unexpected errors and miscommunications between both parties. These miscommunications lead to mistakes such as errors in the orders that are picked for Flying Fish, or an increased lead time.

When an error in picking the order happens, in most times the employees of Flying Fish eFoils have to fix the mistakes themselves by driving to the location of the warehouse. The fact that the travelling time of this trip has increased by an extra thirty minutes has made this process even less efficient. Additionally, Flying Fish constantly has multiple interns in their firm, who only work in the company temporarily. Therefore, after a short period of time the employees of Flying Fish are replaced. Therefore, the allocation of the task to drive to the warehouse and to fix the mistake is done by different individuals, as the team changes often. This has the consequence that the employees do not get familiar with the process at the warehouse, and therefore these trips are not an efficient option.

Furthermore, a problem that is current in the company is the fact that the company has only existed for two years. This explains a shortage of data, that is necessary in forecasting the demand. There is little expertise in the company to deal with this small amount of data. Due to the fact that the product that Flying Fish is selling is seasonal, the little amount of data that the company currently has cannot be clustered. This creates lots of unpredictabilities in the number of sales for the company. The activities of Flying Fish to increase their publicity has the perceived effect of increasing the sales accordingly. Therefore, as the company has the objective to grow their sales with an additional fifty percent, the company focuses on increasing the publicity of their products. However, the increase of sales similarly increases the logistical risks of Flying Fish.

To conclude, as the company wants to increase their number of sales, the warehousing risks potentially increase as well. Warehousing risks could be in the case of FFF are the lack of inventory, carrier delays and non-performance, reputation risk and all the other errors that are caused by an unresponsive supply chain. However, the current structure between Flying Fish and Warehouse X does not seem sufficient for the activities of Flying Fish and likely increase the risks on the logistics of the company even more when it grows. This results in the fact the company has many difficulties in achieving their goal to deliver the products to their customer within the promised five working days. If the company is to grow even further, the process around these causes is picked up more efficiently, and the risks of the warehousing processes are decreased. Therefore, we can derive the following core problem from this cluster:

"Flying Fish eFoils have never analysed the current warehousing performances of their Warehouse X"

In the current situation, the warehousing of Flying Fish Foils is organised by Warehouse X, which results in a lot of difficulties due to miscommunications and different priorities between the two companies. The choice of this warehouse has not been evaluated in the past. On paper, all the warehousing is done by them, but in reality, this is often not the case. This makes a lot of things more difficult for Flying Fish. The result of this is that in the real situation 60 percent of the orders are not delivered within the deadline promised to the customers, although the current norm is the delivery time of 5 days. Achieving these goals is done by analysing the current costs of the warehousing, after

which it can be compared to alternative type of third-party logistics, while considering the potential growth of the company.

1.4 Research goal

To create a possible solution for the problem mentioned in Section 1.3, we describe the goals that we aim for during this project. The objective of our research is to find out whether third-party logistics fits this particular company, and whether it would improve the current operations. Flying Fish eFoils is looking for a warehousing mechanism to decrease the risks of their supply chain. Decreasing the risks prevents delayed delivery times towards the customers and is therefore beneficial for the operations at the company. These logistical choices rely on the preferences of the company as it stands in the market right now, furthermore they are able to deal with the big growth which is projected in the future of the company.

The core business at Flying Fish Foils is to distribute their product throughout the whole of Europe. To do so, their network of contacts is their most important asset. To be able to focus on expanding their network, a lot of attention is being put into that each day. Therefore, the business of Flying Fish want to put as little effort as possible into other purposes. This reason, besides the high potential risk in their logistics, creates interests in whether third-party logistic would improve their current operations. Third-party logistics involve the use of an external company to perform logistics functions that have traditionally been performed by the firm themselves (Dolgui & Proth, 2013). This gives the motivation for setting up this research. Choosing a third-party logistics warehouse is not a simple choice, as it contains many aspects, such as the trust between the company and their warehouse. Therefore, the goal of this research is to support the company of Flying Fish to find a warehouse which can reduce the logistical risks of the company.

1.5 Research question

To create a solution for the current problems at Flying Fish Foils, we are setting up a study. This research bases around one main research question in Section 1.5.1, and four sub research questions in Section 1.5.2.

1.5.1 Main research question

In this research, a lot of elements are kept in mind. To answer the problem of Flying Fish in the best way, the following research question is made:

“How can a third-party logistics warehousing system be organised to decrease the warehousing risks of Flying Fish eFoils?”

1.5.2 Sub-research questions

The sub research questions functions as fundaments for the research question that is mentioned in Section 1.5.1. The sub-research questions have the task to help narrow the broad focus of the main research question. Therefore, for this research, we have used the following sub-research questions:

Sub-research question 1:
“How is the warehousing at Flying Fish Foils organised and performing in the current situation?”

- For Flying Fish eFoils, what are the important characteristics of their business and what quantitative data is currently available for this study?

- For Warehouse X, what are the important characteristics of their business and what quantitative data is currently available for this study?

Sub-research question 2:
"How should a third-party logistics relationship be organised that meets the company's current warehousing expectations?"
- What are the key focus points in warehousing for Flying Fish eFoils?
- What are the important aspects to consider in the decision-making process for evaluating a third-party logistics provider?

Sub-research question 3:
"How should a selection be made between multiple alternatives of third-party logistics providers that meets Flying Fish eFoils' expectations?"
- How can Flying Fish eFoils' expectations and priorities be considered in the decision-making process?
- How can the performances of the third-party logistics alternatives be considered in the decision making?

Sub-research question 4:
"What are the future expectations integrating a third-party logistics warehouse into Flying Fish eFoils?"
- What are the future financial and logistical expectations of the company?
- What potential influences does the integration of third-party logistics potentially have on the risks of the supply chain for Flying Fish eFoils?

A clear structure of the research design is given in Section 1.6. After that, we have considered a theoretical framework in Chapter 3, in which this research is placed. The next step is to go over each individual sub-research question. Following these steps completes the main research question and thus complete the goal of our research.

1.6 Research design

To answer the research questions that are mentioned in Section 1.5, a research design is formulated. This part of the research specifies the problem-solving approach in Section 1.6.1, and the framework that has been used throughout the whole process. After this, the detailed information of this research is elaborated, such as the type of research in Section 1.6.2, the research population in Section 1.6.3, the research strategy in Section 1.6.4 and the scope of the research in Section 1.6.5. The methodology of gathering data is then discussed in Section 1.6.6, after which we elaborate more on the reliability and the validity of this research in Section 1.6.7. Lastly, we discuss the research limitation in Section 1.6.8 and the desired deliverables in Section 1.6.9 to point out the direction of this research.

1.6.1 Problem solving approach

During the research of this assignment, a problem-solving approach is used. We assign a type of framework to this study, to make sure a certain structure and guidelines are constantly considered. During our research, we is using the Managerial Problem-Solving Method (MPSM). This approach exists out of seven steps, in which a problem is solved. MPSM consists out of the following steps (Heerkens & Van Winden, 2021):

1. Defining a problem
2. Formulating the approach
3. Analysing the problem
4. Formulating alternative solutions

5. Choosing a solution
6. Implementing the solution
7. Evaluating the solution

The first two steps of the Managerial Problem-Solving Method mainly focus on during the first three chapters of our research. The step of analysing the problem are mainly done during the chapter of the first sub-question that is mentioned in Section 1.5.2. After that, we are formulating alternative solutions to this problem during the second sub-question. The choice of one third-party logistics warehouse is done during the process of the third sub-question, after which we question the implementation of the solution during the fourth sub-question. By constantly evaluating our research, we develop a feedback cycle. When this cycle is triggered, we align the outcome next to the preferences of the company.

As mentioned, we use the Managerial Problem-Solving Method in the general research purpose of this study. Additionally, during each individual sub-question mentioned in Section 1.5.2 we are going to use this method, as it increases the structure and the transparency of this research.

1.6.2 Type of research

To achieve our goal for this research, we define the type of this research. Whether this research is explanatory, exploratory, or descriptive research, defines the path to solving the research problem. During this research, we focus on finding a solution for the company Flying Fish on their logistical area. As this research mainly focusses on why a certain warehousing system fits to certain companies, this study is explanatory research. The purpose of this study is to explore a new universe for the company, which has not been studied earlier (Akhtar, 2016). This is thus a "Why" question. After we answer the why-question, the application is made towards the company.

1.6.3 Research population

To achieve the right focus for the company, a research population is installed. The research population are mainly the third-party logistics providers in Europe. After focussing on the preferences of Flying Fish, the base of this study is about comparing and finding the right solution on that exact research population. We have investigated this population, after which the best partner for Flying Fish Foils is chosen.

1.6.4 Research strategy

During each stage of our research, the strategy that we use differs. A stage is mainly distinguished by the different sub-questions of this research. During the first stage, we investigate the data that the company currently has of its past performance. This means that we emphasize the current warehousing strategy, and what effects it has on the current routines. When the current situation at Flying Fish is depicted, we are doing research on solving warehousing issues at companies in general. This process provides a lot of insights into the current situation of both Flying Fish and Warehouse X, which is beneficial throughout the rest of this project.

During the second stage of the research, we set the important factors, priorities, and benchmarks in the company, from which the Key Performance Indicators can be made. These KPIs all consider the important measurable elements of the research and mainly are quantitative (Heerkens & Van Winden, 2021), as for instance the number of sales of the company. Making them quantitative makes it less complicated to keep track of the potential improvements. These KPIs may come from direct data but can come from estimations or calculations. Some KPIs are qualitative, as it depicts the needs of the company, such as the personal relationship with another party. To create the best KPIs to support this research, we study literature on this matter, as it is an important base of the research.

The third stage exists out of the exploration of different types of options on outsourcing the warehousing to a third party. We make contact with some third-party warehousing companies, and investigation upon all information is done. This research gives a broad view on how the preferences of the company are reflected in the market of the third-party logistic warehouses. We investigate further on the financial assets of the company, on whether a possibility like this is taken. Additionally, we analyse the influences of the outsourcing decision on the effects it might have on the KPIs.

In the last stage of this research, we found a useful strategic option for a third-party logistics, that helps the company stay competitive. The research emphasizes the integration of it into Flying Fish. We provide a plan on how to access the improvement step by step. Furthermore, we provide a clear recommendation which concludes all the findings in this study. Lastly, the research depicts the future effects in this stage.

1.6.5 Scope

The scope of our research points out what elements of the company we consider. This means some elements that have to do something with the warehousing of the company are not in the scope of our research, as our focus is put onto other warehousing factors.

This research mainly focuses on the effects that third-party logistics have on the company. This study does not focus on other warehousing possibilities, as this has the preference of the company. The goal of this research is to improve the current situation of the warehousing, without changing other variables that are part of the company, such as the products that they are currently selling. Additionally, this company's core business is the distribution of their products, wherefore the supply chain is considered as important. However, we are not inspecting the supply chain outside the warehouse.

Furthermore, this research solely focuses on changing the warehousing system to a third-party logistical warehousing system. This means that the specific warehousing strategy of Flying Fish eFoils not be considered. Therefore, we are not providing any inventory forecasting nor any inventory management for the company of Flying Fish eFoils. However, these subjects are considered in the recommendations on future research for Flying Fish.

1.6.6 Data gathering

Gathering data throughout our research plays a fundamental role in improving the current situation at Flying Fish. The internal and external data define the current structure and point out the different opportunities within the company. The data and information comes from several sources, such as literature studies, databases of the company, interviews, questionnaires, and feedback.

The literature on outsourcing warehouses is important, as this guides the research in how to set up a third-party warehousing relationship. As mentioned above, this comes in usefully describing the needs of the companies, in the form of Key Performance Indicators. The literature data gathering is mainly done with the databases Web of Science, Scopus.

The databases that we use are filled with data from the current performance measured from the past sales of the company. However, as the company is still a start-up, the data does not go back more than two years. Therefore, during the research we sometimes have to make calculations which are based on estimations. We interview with the employees of the company. To find out what the Key Performance Indicators of the company are, we gather data on the needs and the priorities of the company. Interviews with the employees of the company point out the important factors, such as the vision of the company and the direction that Flying Fish is heading.

Lastly, the conversations with the instructor and the company of Flying Fish eFoils are important. The feedback of the company and the instructor is important, as this points the research into the right direction. These opinions declare the vision of the company even more, at which the desired target is then best reached.

1.6.7 Reliability and validity

Reliability and validity are important factors of the research. Reliability itself refers more towards the consistency of the measures. This means that whether the results behave the same under the same circumstances in different research. Validity refers more towards the accuracy of the measurements; this means that the result of the research depicts what it really is supposed to measure.

In terms of validity, there are two types: Internal validity and external validity. Internal validity is about the degree of confidence that the research is about the right causal relation, this means that it is not influenced by other variables. External validity is the degree to which results can be applied to other studies or situations. Maintaining a high level of reliability and validity is important for well-founded research, as it extracts all the elements that wrongly interpret the real target of the study. Therefore, during this research our reliability and validity weigh heavy in the process. In terms of reliability, we focus on the fact that this research can be reused in other situations and research. The raw data is sometimes be shaped into a form that is more functionable for the research. Throughout the whole research, we focus on the objectiveness from each shaping process, and we focus on them being well-thought and well-documented. We focus a lot of on the description of the research design, as this creates a clear view on how this research is handled. A high level of reliability can create the possibility for other companies to use the decision-making tool that is created.

Otherwise, in terms of validity there are a couple of elements to consider during the process. We can provide a lot of external validity by using reliable sources. If the data from other situations and companies are interpreted well, this gives the right directions to the external validity. Throughout the entire research, we constantly go through a feedback cycle to produce more internal validity. If something is planned and done, we always check the steps that are made again. Thinking outside of the box helps in this process. Moreover, by often receiving feedback a discussion is created in which validity is questioned. Therefore, this is something this research focuses on.

1.6.8 Research limitations

A limitation of this research is that the current pandemic of Covid-19 has its effect on the research. The fact that the company of Flying Fish was introduced after the pandemic has started, the effects of the current market differ from the market without the virus. People and thus buyers behave differently during the pandemic, compared to outside the pandemic. Additionally, due to this pandemic international logistics have changed temporarily which affects our study.

Another limitation is the young age of Flying Fish as a company. The fact that they have only existed for two years potentially introduces a lot of difficulties into our study. The little amount of data is a restriction for instance for the expected demand and other elements that are significant for our research. The fact that that they have only existed for two years has the effect that they do not yet know where they want their future position to be. Therefore, the expectations change over time, which means that the potential result possibly is not in the direction that the company wants.

A possible limitation for this research is the time frame in which it is concluded. In the given time frame, the research perhaps is not done as thoroughly as possible. This has a negative effect on the sample size of the research. The consequence of this is that the research does not cover the whole research population.

The last limitation to our research is about the calculations with the transportation of the products towards the customer. Those calculations contain many estimations, due to the fluctuating transportation prices at the companies. For instance, the fluctuations and future expectations of transport costs cannot be considered. Furthermore, due to privacy reasons of the customers of Flying Fish Foils, only the distances between the middle points of two countries can be considered in our calculations, as the personal address of the customers violate that privacy.

1.6.9 Deliverables

This research for Flying Fish eFoils is done with a certain type of target on the horizon. To be able to reach that target, clearly structured goals are set, in the form of deliverables. The following deliverables are finalised to create the output of our research:

- A literature study on how third-party logistics from a company influence the core business of a company.
- A detailed Multi-Criteria Decision-Making tool on the alternatives of Third-Party Logistics, which is linked to the interests of the company.
- An extensive cost analysis consisting future expectations of integrating third-party logistics into Flying Fish eFoils.
- An implementation plan on the integration of a new possible third-party logistics warehouse.

1.7 Summary

In this chapter, the goal was to introduce the company and the study that is assigned to it. Flying Fish eFoils is a start-up company, which has the rights to distribute the electrical surfboards from Chinese company Waydoo in the whole of Europe. They currently use a Warehouse X, which is assigned via an acquaintance. However, the problem with this is that more than 60 percent of the orders are delivered too late, which is partially caused due to the fact that Flying Fish is not the top priority of Warehouse X, as they have their own businesses to run as well. Flying Fish have never analysed their warehouse performance before, and therefore, they are interested in assigning a third-party logistics warehouse, which decreases the risks of the logistical operation of the company, such as the lack of inventory. Our main research question is “How can a third-party logistics warehousing system be organised to decrease the warehousing risks of Flying Fish eFoils?”.

The research is done following the Managerial Problem-Solving Methodology. This creates important areas of feedback throughout the research, which have the function to align the study next to the concerns of Flying Fish Foils. This research focuses on an explanatory study, to investigate the different options of third-party logistics for Flying Fish Foils, without having to change any other variables that play a role in the company. We aim for a high level of reliability and validity through intensive documentation of the choices that we make. To create a clear view on the operations at Flying Fish and at Warehouse X, we narrow our study to the current performance of the operations at both companies.

2. Current situation

This chapter analyses the current warehousing situation at Flying Fish eFoils. The causes of the problem are elaborated on, and all the relevant aspects that are taken into account for this study are specified. In Section 2.1 we go over the general operations of Flying Fish, after which Section 2.2 specifies moreover the relevant characteristics of the logistical operations at Flying Fish. Section 2.3 elaborates on the logistical operations at Warehouse X.

2.1 Flying Fish eFoils

By going over the general characteristics of Flying Fish, we go into further details on the specific elements for this study. As mentioned in Section 1.1.1, the company focuses on selling a type of electrical surfboards. The company of Flying Fish is constantly focussing on the growth of their sales. In 2021, the company has sold a number of 415 boards in total, distributed over 215 different orders. Although the company has existed for only two years, a trend in the sales can be acquired. Although the sales of only one year are displayed in Figure 3, since the start of the company the sales of the electrical surfboards are completed with potentially a seasonal behaviour, as the most boards are bought in preparation of the summer or during the summer season itself. This can be explained by the fact that an electrical surfboard is a product which is mostly used with sunny weathers. The rise in sales can be explained by the e-foil being a water sports product, that is used and thus bought more often in the summer.

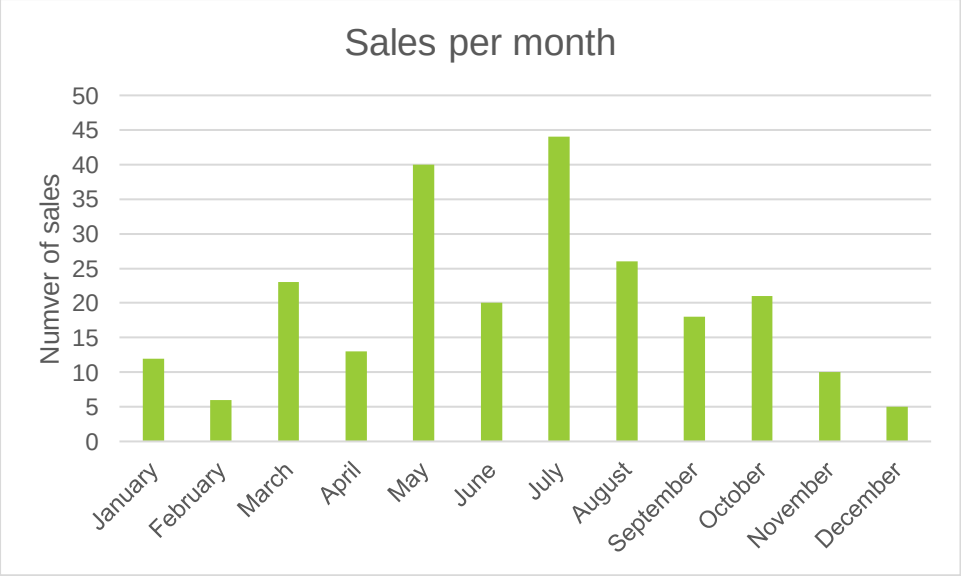

FIGURE 3 SALES PER MONTH

Whenever a customer wants to place their order, a structured process is started, in which a personal touch is important. As visible in Figure 4, there is a lot of contact between the two parties before the final shipment is started. Through close contact and personal discounts, the best price for an order is agreed to. The inventory is then checked, after which an estimated delivery time can be discussed. As an e-foil is expensive and there is often no inventory, the customer pays a down payment of thirty percent on the order, so that the company knows that the order is completed on part of the customer. Whenever the order would be cancelled after that, the thirty percent is not refunded. Whenever the order is ready to ship in Warehouse X, Flying Fish asks for the rest of the payment, after which the shipment to the customer can be started.

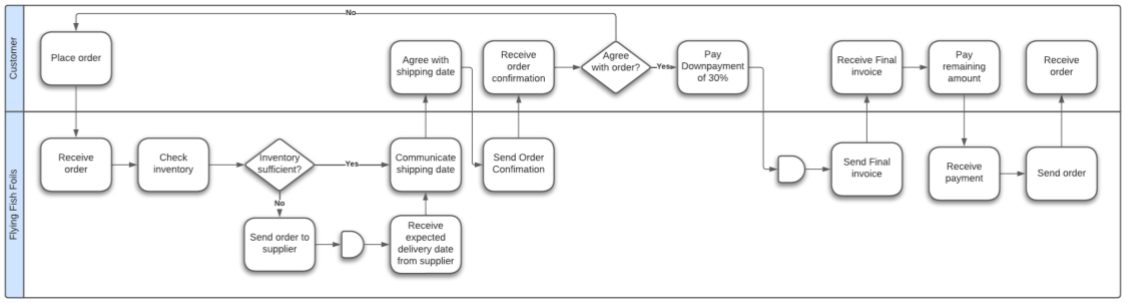

FIGURE 4 ORDER PROCESS CUSTOMER

2.2 Flying Fish' logistics

The core business activity of Flying Fish eFoils is to distribute a product that is made in China over the whole of Europe, as mentioned in Section 1.1.1. They have the exclusive right for these countries and with that, a lot of logistical processes are important for the company. Therefore, we introduce all the important factors of these logistics, which are needed for our study.

In Figure 5, the process of ordering new inventory is depicted. New inventory is not ordered until the moment that the company realises that it is currently selling backorders to their customers. After Flying Fish has decided on what to order, an agreement in costs and expected delivery date is made between the parties. After this has been done, the supplier can start manufacturing the goods that are ordered, as they produce the e-foils to each order. Although there are 4 different types of boards available, there is no customisation possible. During this period, for every order Flying Fish starts to seek for a shipping company. As the company has only existed for two years, they did not yet spend attention to attaining a useful relationship with one specific company. Therefore, for each order they place, they investigate multiple companies that fulfil this process.

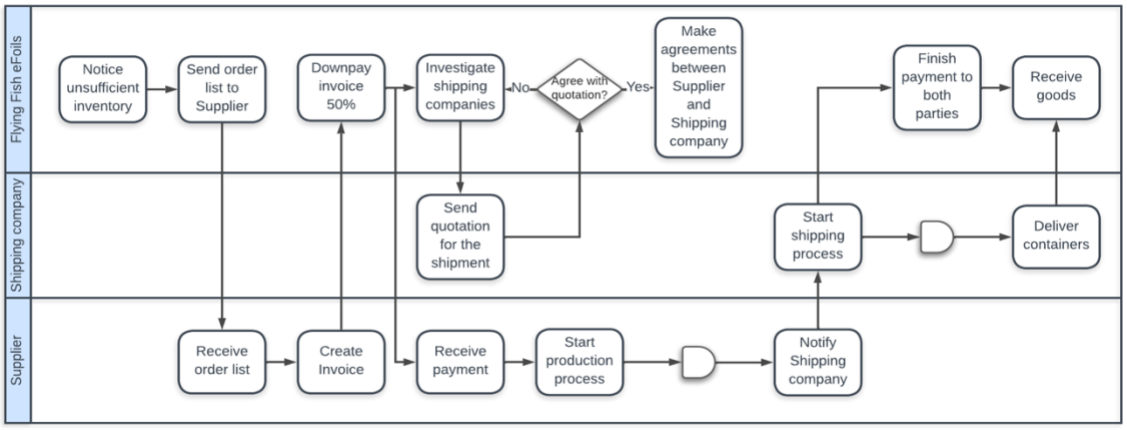

FIGURE 5 ORDER PROCESS SUPPLIER

Flying Fish currently focuses on selling their boards. The company currently sells two different boards: One type made out of Expanded Polypropylene (EPP) foam, and one type made out of carbon fibre. The carbon fibre board has a higher quality but is more expensive. Both of these boards can be bought with two different variations in wing size, a big wing size which provides the most support for starters or heavier or taller consumers, and a smaller wing size which can be for the lighter or smaller consumers and can be more adventurous. Next to these four combinations, Flying Fish provides up to 22 types of small parts, that the customer can buy. This can for example be a new wing for warranty reasons, or a spare battery to enjoy the board for a longer period.

Specifications	**Company of carriage**
Package <20 kilograms	DHL
Spare Batteries	UPS
Package >20 kilograms	DSV

TABLE 1 CRITERIA PER SHIPPING COMPANY

The surfboard packages and the spare parts have to be shipped to the customer once the full payment is received. This shipping process is executed by a shipping company that is chosen after certain criteria, which are mentioned in Table 1. As visualised in Figure 6, once the shipping company has been chosen, an invoice is sent towards the customer, who can then choose whether to agree with the current quote for shipping, or whether to take care of the shipment themselves. Due to these uncertainties, there is no real indication on what the shipping for an order might costs which can cause big variations in the shipment costs between orders.

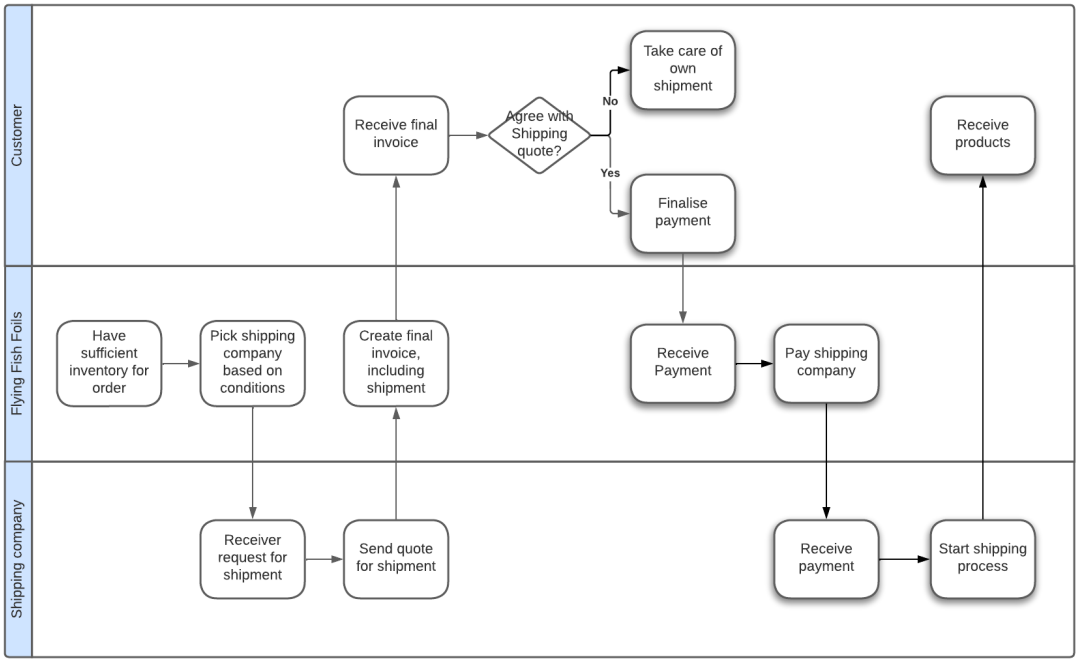

FIGURE 6 SHIPPING PROCESS CUSTOMERS

Whenever the shipping company has been contacted, the products from Flying Fish are sent towards the customer. As mentioned in Section 1.1.1, Flying Fish has the exclusive rights for the distribution in the whole of Europe. In up to 32 countries FFF has got customers within and outside of Europe, Flying Fish has got dealers which are the connecting link between the Flying Fish and the private consumers. As the largest customer base of FFF is in Europe, in Figure 7 a map with all the countries within Europe where the sales are located is visualised.

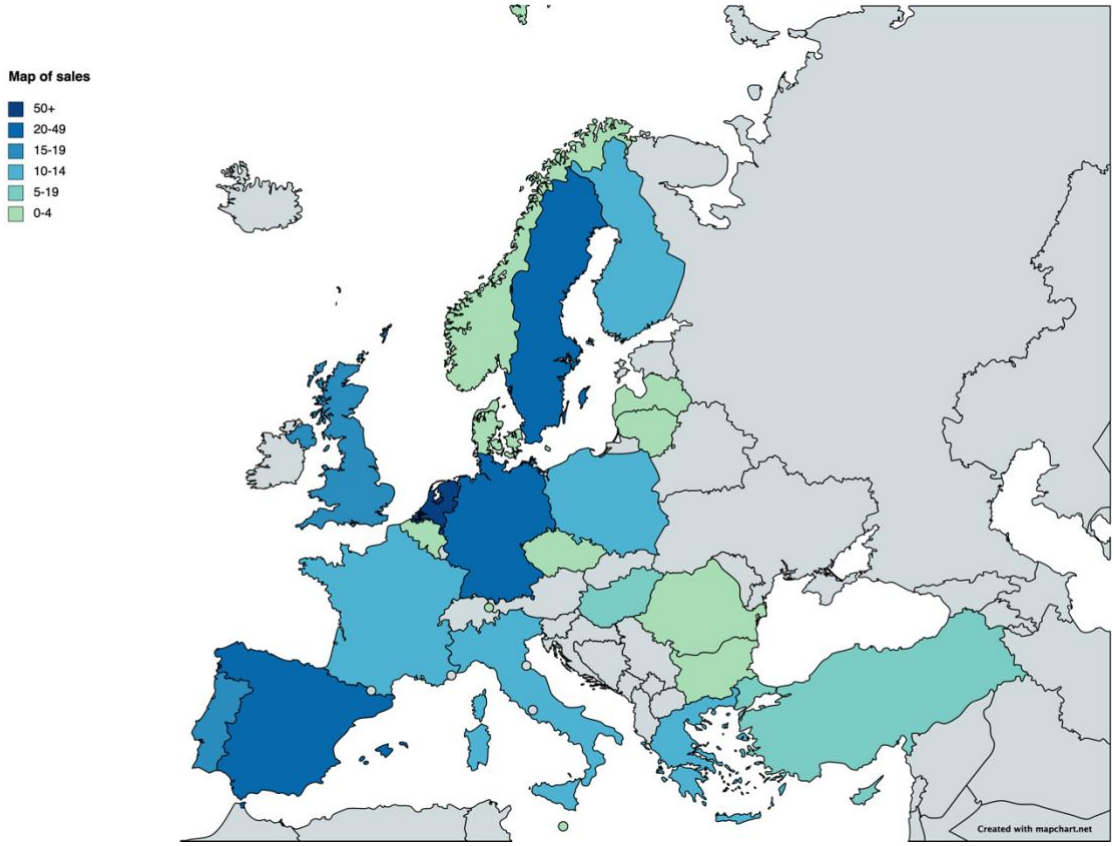

FIGURE 7 MAP OF CUSTOMERS IN EUROPE

Until December 31st of 2021, the company has processed a total of 215 sales across the world. From this total, only 89 orders have been delivered within the promised timespan of five working days. Therefore, 60% of the orders are not delivered within that promised time. This can cause a decrease in trust from the customers, which can have negative effects for the long term of the company (Utami, 2015).

The current inventory management is not done accurately. There is no real systematic approach, as the stock is only counted once on a random moment in approximately every three months, after which all stock positions are not monitored. Often there is a lack of insights in their stock positions which can have negative effects, for instance if the stock suddenly runs out. Moreover, in the bookkeeping system that the company uses, some inventory levels are negative, and generally does not correlate with the real values. This can be a big problem when it comes to inventory management.

2.3 Warehouse X's logistics

During this study, our goal is to improve the current warehousing of Flying Fish. To do so, we consider the current logistics at Warehouse X. The company of Warehouse X is located in Wieringerwerf. They own a warehouse with a total surface of 18,000 squared metres. In Section 1.1.2 we have mentioned that the core business function of Warehouse X is not to store other company's inventory: The core activity is to buy all sorts of cheap items and to sell them again to different bargain shops.

When Flying Fish has to send an order towards a customer, they contact Warehouse X as visualised in Figure 8. After a shipping date is agreed upon, all the documents are prepared and sent to Warehouse X. After they have received the documents, they have the time to prepare the order and to hand it over to the shipping company, whenever the picking date is planned.

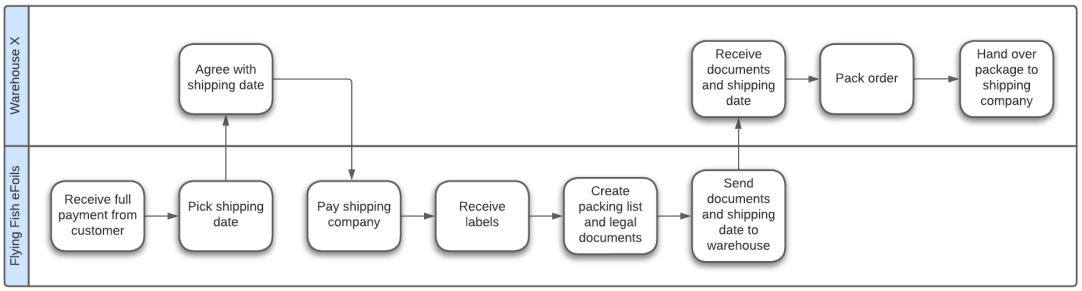

FIGURE 8 SHIPPING PROCESS VIA WAREHOUSE X

As Flying Fish is the only company which rents space from Warehouse X, the parties agreed on personal terms when it comes to the warehousing prices. As visible in Table 2 Warehouse X distinguishes their prices in the size and weight. A small package, which for instance is sent for warranty purposes, costs less to prepare than an order existing out of multiple pallets. Additionally, to a price for each label that is printed, Warehouse X have a holding price per stacking rack per month which can carry three boards per rack.

	Price	**Unit**
Package <20 kilograms	EUR 8	Per package
1-2x pallet	EUR 15	Per pallet
3-4x pallet	EUR 12	Per pallet
>5x pallet	EUR 10	Per pallet
Labels	EUR 5	Per label
Stacking rack	EUR 10	Per month

TABLE 2 WAREHOUSING PRICES

2.4 Warehousing characteristics

In this section, information is gathered with the information from the current warehousing system. This information serves as a benchmark in the decision-making process when evaluating multiple alternatives, in comparison to the current structure.

When it comes to the orders they place to their supplier, Flying Fish mainly makes use of shipment by boat. This process takes up to three months. The time between the agreement of an order, and the departure time from the supplier is approximately one month, in which the ordered products are produced. After this production time, another two months are approximated when it comes to the shipment by boat.

The type of shipment of outgoing orders varies per order. If possible, the option to transport the boards by road is manually be chosen for each individual order, as this is the cheapest method. Although transportation by road takes more time when it comes to orders that are further away in comparison to flights. In that case, and in cases in which this type of shipment is not possible, for instance to customers which are located on islands, shipment by air is chosen.

An e-foil is packed in a carton box, with the dimensions of 178cm x 46cm x 84cm and weighs up to 55 kilograms. This adds up to a total of 0.7 cubic metres per board, with a weight density of 79 kilograms per cubic metre. When shipping an e-foil board, the important part to consider is that there are a lot of safety rules and restrictions for sending battery types. The effect of this is that the prices and the labour that is put into an order is higher in comparison to normal packages, as it contains dangerous goods which contain strict measures when transporting internationally.

2.5 Analysis of current data

We analyse the current available data, which we need to create important insights into the company. This is done to achieve many key performance indicators (KPIs) and current costs within the company, which has a play in creating a useful third-party logistical relationship.

2.5.1 Average order size

In Section 2.1 we have already computed the number of orders per month, which resulted in the conclusion that the demand of the product shows seasonal effects. To be able to gain knowledge about the orders that FFF sends to their customers, the order sizes are important. The current bookkeeping system does not keep track of the number of boards that are ordered by the customers per order. Next to that, we have already concluded that the inventory is not counted in a certain structured time interval. Therefore, the company has no insights in these numbers. To create these numbers, we can look at the total order values, which the customers had paid. Flying Fish eFoils uses a quantity discount for the orders of their customers. Therefore, we cannot calculate with a firm price for the boards, but the intervals between those discounts are used. By applying these pricing intervals to the order prices, we can attain the number of boards per order.

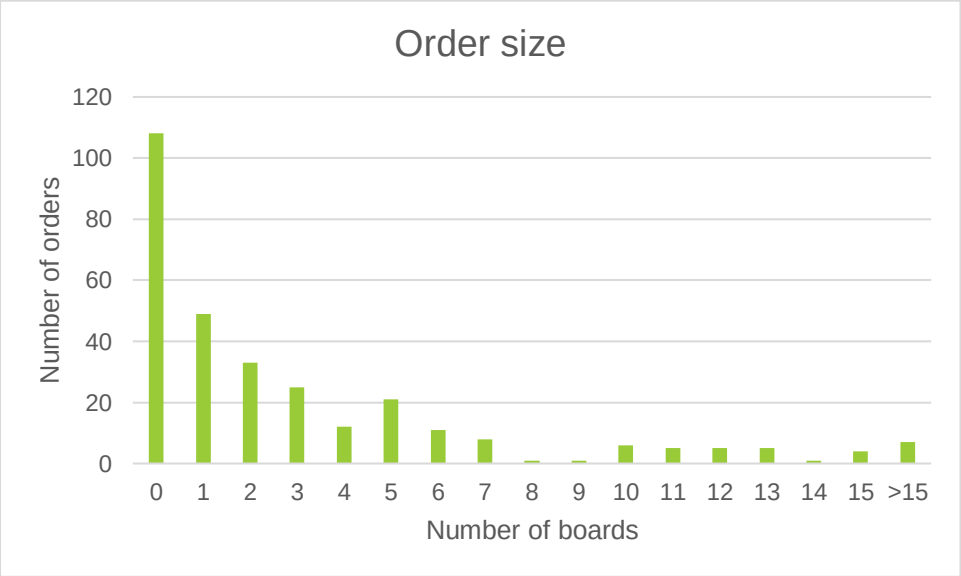

FIGURE 9 ORDER SIZE

Considering the order sizes in Figure 9, the number of orders in which no boards were ordered is high. These orders often consider the shipments in which broken items are replaced. The reason for this can be that the eFoils are still in the starting phase, in which the strength and the durability of the product have not been particularly high. Furthermore, from this information we can conclude that the average order contains 3.3 boards, or whenever the orders without any board are deleted from this equation, an average of 5.1 boards per order.

2.5.2 Average lateness

According to the current promises of the company, an order is delivered with a lead time of five working days. When we analyse the data that is available within the company, we can see that this is often not the case. In Table 3 the average lateness in days is calculated. We can derive the average delivery time to be 41.6 days and an average lateness even higher 74.5.

Month	Number of orders delivered	Number of orders late	Average delivery time in days	Average lateness in days
January	18	10	43.8	86.6
February	16	16	72.1	94.1
March	32	23	37.2	63.3
April	17	16	29.3	59.0
May	18	14	26.4	46.6
June	19	16	48.8	57.9
July	39	11	10.8	36.6
August	13	6	5.6	11.8
September	19	6	44.5	141.0
October	27	19	41.9	56.8
November	22	17	84.5	121.1
December	9	0	54.3	119.4

TABLE 3 AVERAGE LATENESS IN 2021

2.5.3 Inventory level

In Section 2.4, we concluded that the inventory levels are not updated a lot, and that there is a high lack of insight in the inventory for the company. However, the inventory levels of the company can play a big role in this study, as this is directly connected with the volume that is used in a warehouse. Considering the incoming and outgoing orders, an estimation can be made on how many boards are in stock at the times, as displayed in Figure 10. This information is thus not concluded from inventory counts, but from the incoming and outgoing orders. This affects the validity of the inventory results, as a lot of the data was not in inserted at the correct moments with the correct quantities.

FIGURE 10 INVENTORY AT WAREHOUSE X

In Section 2,4 we gathered the information that the volume of a board in inventory is 0.7 cubic and the weight from the boards in stock is 79 kilograms per cubic metre. With this information, we can imply that the average volume of boards in inventory is 50.7 cubic metres. Furthermore, the weight of the inventory approximately is 4,005 kilograms.

2.5.4 Holding costs

In Section 2.5.3 we have gained knowledge about the inventory levels. We know from Table 2 that Flying Fish currently pays 10EUR per stacking rack, which can stack up to three boards. As Warehouse X now counts the used stacking racks each first of the month, we can derive the used number of racks used at that moment in relation to the inventory. In Table 4 we can derive the holding costs according to the stock levels.

Month	**Number of boards in stock**	**Holding costs**
Sep/20	29	€ 100.00
Oct/20	29	€ 100.00
Nov/20	1	€ 10.00
Dec/20	1	€ 10.00
Jan/21	1	€ 10.00
Feb/21	34	€ 120.00
Mar/21	68	€ 230.00
Apr/21	25	€ 90.00
May/21	276	€ 920.00
Jun/21	91	€ 310.00
Jul/21	242	€ 810.00
Aug/21	111	€ 370.00
Sep/21	40	€ 140.00
Oct/21	7	€ 30.00
Nov/21	0	€ -
Dec/21	0	€ -
Jan/22	129	€ 430.00
Feb/22	112	€ 380.00
Mar/22	104	€ 350.00
Apr/22	100	€ 340.00
May/22	121	€ 410.00
Total		€ 5.160.00

TABLE 4 HOLDING COSTS

2.5.5 Packing costs

In Table 2 the costs for having inventory at Warehouse X are stated. Considering the costs for picking an order, it is essential to know how many boards are contained in an order. In Figure 9 we have calculated the order sizes at Flying Fish. Whenever an order contains no boards, it often qualifies for the restrictions of being of less weight than 20kg. However, when an order contains a battery, it is not less than 20kg, and is thus calculated similarly as an order that requires to be on a pallet.

Number of boards	**Number of orders sent**	**Total packing costs**
0	93	€ 1.391.00
1	44	€ 220.00
2	25	€ 125.00
3	22	€ 440.00
4	9	€ 180.00
5	18	€ 360.00
6	9	€ 315.00
7	7	€ 203.00
8	0	€ -
9	1	€ 41.00
10	5	€ 205.00
11	2	€ 82.00
12	3	€ 159.00
13	4	€ 180.00
14	0	€ -
15	2	€ 110.00
>15	4	€ 320.00
Total		€ 4.331.00

TABLE 5 PACKING COSTS

2.5.6 Distance to the customer

To calculate the ideal situation to base a future warehouse, we know where the demand of Flying Fish' product is located. By extracting the countries where the customers are located, we can calculate the distance to those customers. However, due to privacy reasons, we can now only consider the country of origins. In Table 6 we use the centre point of a country for our calculations. The average distance travelled by road is 1,182 kilometres, which are within a driveable reach from Wieringerwerf. When it comes to the orders that do not fall within the driveable span of the shipping company, the shipping company decides to travel by air. The average travel distance of these orders is equal to 6,153 kilometres.

Country	Number of orders	Distance	Preferred shipment	Total distance
Belgium	0	236.39	Road	0
Bulgaria	1	1,877.98	Road	1,877.98
China	0	7,582.58	Air	0
Curaçao	5	7,858.00	Air	39,290.00
Cyprus	7	2,959.11	Air	20,713.77
Czech Republic	4	773.49	Road	3,093.96
Denmark	1	475.30	Road	475.30
Dominican republic	0	7,370.39	Air	0
Finland	8	1,724.55	Road	13,796.40
France	12	792.41	Road	9,508.92
Germany	26	402.21	Road	10,457.46
Greece	8	2,013.39	Road	16,107.12
Hungary	7	1,250.26	Road	8,751.82
Italy	10	1,255.35	Road	12,553.50
Latvia	2	1,351.15	Road	2,702.30
Liechtenstein	1	709.04	Road	709.04
Lithuania	3	1,264.30	Road	3,792.90
Malta	1	2,021.89	Air	2,021.89
Mayotte	5	8,245.36	Air	41,226.80
Norway	3	1,059.26	Road	3,177.78
Poland	11	1,017.83	Road	11,196.13
Portugal	13	1,772.33	Road	23,040.29
Romania	1	1,625.52	Road	1,625.52
Seychelles	1	7,945.35	Air	7,945.35
Slovakia	0	1,116,74	Road	0
Spain	14	1,584.72	Road	22,186.08
Sweden	20	1,176.66	Road	23,533.20
Switzerland	0	684.67	Road	0
The Netherlands	57	82.81	Road	4,720.17
Turkey	7	2,751.91	Road	19,263.37
UAE	3	5,241.89	Air	15,725.67
Ukraine	0	1,926.20	Road	0
United Kingdom	12	618.47	Road	7,421.64

TABLE 6 DISTANCE TO THE CUSTOMER

2.5.7 Transportation costs

Due to changing prices in Transportation, transportation prices constantly shift. Therefore, when considering the transportation costs of the products of Flying Fish eFoils we generate the average paid price for an order towards that company, as shown in Table 7. This means that the average price is measured by the prices of the shipping companies mentioned in Section 2.1. The average price per kilometres travelled by road is €0.36 as opposed to €0.29 per kilometre by air. This can be explained due to the fact that the distances are significantly larger, and the plane can transport more carriage.

Country	Number of orders	Distances	Average Price
Bulgaria	1	1,834	€ 456
Curacao	5	7,872	€ 830
Cyprus	7	2,918	€ 1,236
Czech Republic	4	759	€ 323
Denmark	1	535	€ 280
Finland	8	1,636	€ 438
France	12	693	€ 308
Germany	26	372	€ 210
Greece	8	1,931	€ 483
Hungary	7	1,160	€ 370
Italy	10	1,266	€ 361
Latvia	2	1,348	€ 425
Liechtenstein	1	632	€ 310
Lithuania	3	1,267	€ 410
Malta	1	1,938	€ 1,211
Mayottes	5	8,173	€ 1,418
Norway	3	948	€ 401
Poland	11	947	€ 230
Portugal	13	1,756	€ 380
Romania	1	1,584	€ 630
Seychelles	1	7,884	€ 1,400
Spain	14	1,472	€ 507
Sweden	20	1,210	€ 426
The Netherlands	57	0	€ 138
Turkey	7	2,724	€ 991
UAE	3	5,186	€ 1,350
United Kingdom	12	677	€ 326

TABLE 7 AVERAGE TRANSPORTATION COSTS PER COUNTRY

2.7 Summary

In this chapter, we focused on describing the current situation at the company Flying Fish. During our study, we gained the knowledge that the e-foil boards are a seasonal product, which are bought more often in preparation for, or during the summer. The company has the exclusive rights to sell the board in the whole of Europe. In 2021, they have sold up to 415 boards in total in 215 different orders distributed over 32 countries which are mostly located in Europe. From these sales, more than 60% of the orders are not delivered within their promised time span of five days, with an average lateness of 74.5 days. The shipping process is executed by a shipping company that is chosen following certain criteria, depending on the size of the order. The dimensions of an e-foil are 178cm x 46cm x 84cm with a weight density of 79 kilograms per cubic metre. The holding costs, which were 5,160 euro based on the prices in 2021, are based on the number of boards, and the packing costs depend on the order sizes and weights. Furthermore, the inventory management is currently done not accurately, due to no real systematic approach. To create a warehousing system that suits Flying Fish better, our study aims for achieving a high-level literature study on third-party logistics, a detailed comparison table, a list of the KPIs, an extensive scenario analysis and an implementation plan.

3. Theoretical framework

To solve the core problem that is mentioned in Section 1.3, a theoretical framework is needed. This theoretical framework considers the elements needed for the approach of this study. In the theoretical framework, some concepts are elaborated, with the definition and the application to this study. In Section 3.1 we go into further details about setting up a relationship with a third-party logistics warehouse. In Section 3.2 we gather more information on how to consider the Key Performance Indicators of the company of Flying Fish. Analysing these KPIs gives about the important priorities of the company. These priorities are linked to the priorities of third-party logistics warehouses, via the information of a Multi-Criteria Decision-Making tool, for which we gather information in Section 3.3. This tool is then sent to companies via a questionnaire, which we cover in Section 3.4. After gathering our results, we focus on implementing these results via Scenario Analysis, for which the approach is elaborated on in Section 3.5.

3.1 Third-party logistics

For our study, we want to improve the current situation at Flying Fish. As mentioned in Section 1.4, the company is interested in implementing a new warehousing system. There are three possibilities for a company to take care of their warehousing system: They build their own self-distribution facility, they use outsourcing option to third-party logistic providers, and they can develop on-demand warehousing capabilities (Unnu & Pazour, 2019). Each option of those has their own influence on a company, however, as mentioned in Section 1.6.5 this research dives into the third-party logistic provider's influence.

TPL, short for Third-Party Logistics, involve the use of external companies to perform logistics functions that have traditionally been performed by a firm. Dolgui and Proth (2013) define outsourcing as "the act of obtaining finished products from an outside company if these activities were traditionally performed internally". As visible in Figure 11, the difference between non-integrated logistics providers and TPL providers is that a company with integrated TPL can outsource main activities of their supply chain, to focus on other elements in their company (Núñez-Carballosa & Guitart-Tarrés, 2011). This works the same for Flying Fish eFoils, which would currently take the role of the last warehousing and distributing, before the product reaches the consumer. To make this work, a lot of focus is put into the relation between the companies. It is important for a successful outsourcing cooperation's philosophy that the buyer is a partner with the supplier (Kučera & Chocholáč, 2016). This relation can operate only in compliance with the high level of cooperation, collaboration and exchanging of information. Both cooperation partners must trust to each other. Otherwise, this relation cannot work and both cooperation partners will not use any advantages from the synergy effect.

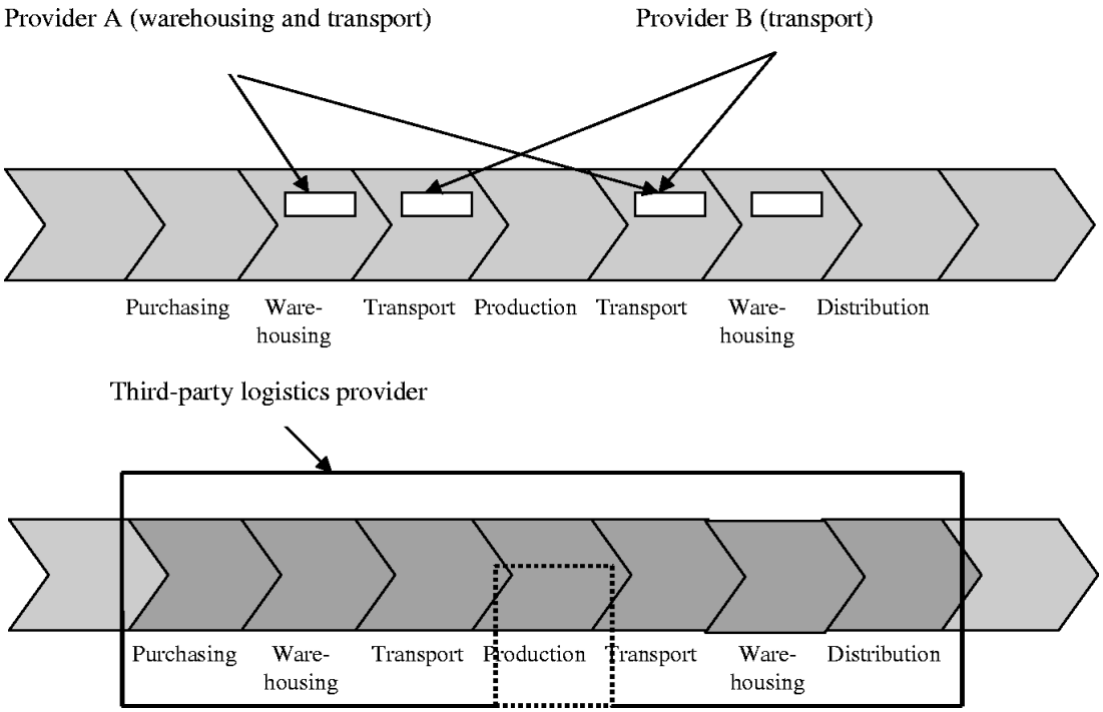

FIGURE 11 NON-INTEGRATED LOGISTICS PROVIDERS VS TPL PROVIDERS (Núñez-Carballosa & Guitart-Tarrés, 2011)

A successful outsourcing partnership can be beneficial for companies. First of all, it is important for the competitive advantage of a company (Seth, Deshmukh, & Vrat, 2006).This is due to the flexibility of delivery of goods and the supply chain integration. This can have beneficial effects on elements such as the customer satisfaction, efficiency of the operations, reduced investment base, broader range of services, and access to internationally set up distribution networks (Bask, 2001). Next to that, it makes sure that the company itself has the privilege to focus less on the logistical area, which creates opportunities to focus on their own core activities even more. The logistical area is overall influenced positively, as the professional skills and technologies of the specialised company are used (Dolgui & Proth, 2013).

It is important to keep a healthy relationship between the parties. They must always function as partners, as that is a healthy basis of the relationship. A danger of outsourcing such a large part of the company, is the loss of control. The third party-warehouse might have other aims than the company, such as maximising their own benefits and profitability (Vaxevanou & Konstantopoulos, 2015). Other drawbacks can be the lack in understanding of the company's supply chain needs, the lack of adequate expertise in specific products, lack of logistics cost awareness by the company, and above that, the company has to share their internal information, which can lead to a big dilemma (Dolgui & Proth, 2013; Wilding & Juriado, 2004).

When the choice is made over which party to use for their warehousing operations, a couple of important elements have to be taking into account. Sink and Langley Jr (1997) have described six dimensions of selection criteria: (1) quality, (2) cost, (3) services, (4) performance metrics, (5) information system and (6) intangibles. Some of these can be measured quantitatively, others are having to be considered qualitatively, such as the global scope. In Table 8, each dimension is divided into more detailed criteria.

Dimension	**Criteria**
Quality	- Continuous improvement - Iso compliance - KPI tracking
Cost	- Price - Continuous cost reduction - Cost control of value-added services
Services	- Value-added services - Customer support service - Responsiveness - Service effectiveness
Performance	- Problem-solving capability - Document accuracy - Transportation safety - Shipment error rate - On-time delivery
Information system	- Data integrity and reliability - Network security - System stability - IT infrastructure scalability
Intangibles	- Experience - Global scope - Financial stability

TABLE 8 TWO-LEVEL HIERARCHY OF KEY TPL SELECTION CRITERIA

In conclusion, outsourcing the warehousing operations can have a lot of beneficial effects, but the relationship with the party is important. The third-party distributors have to be considered as partners, otherwise, it can have negative effects.

3.2 Key performance indicators

To build the trust between Flying Fish and a potential TPL partnership, we focus on finding a potential partner that has a comparable vision. This comparison can be made by the six dimension described by Sink and Langley Jr (1997). These dimensions can be aligned with the Key Performance Indicators (KPIs) from Flying Fish. The definition of KPIs are customizable business measures utilized often to visualize status and trends in an organization (1Kaplan & Norton, 1996, pp. 75-85). Key Performance Indicators indicate the priorities of the company in measurable elements. Ideally, these KPIs are quantifiable, so that it is easy to compare the statuses of the performances of these measurements (Heerkens & Van Winden, 2021). A Key Performance Indicator must always be clear and structured, which is directly display in the important elements of the company. They must notify the company on what elements improvements can be made.

During our research, we use Key Performance Indicators at Flying Fish eFoils. Together with the opinion of the employees, we find the important factors to keep considering throughout the process. This is for instance the average delivery time, the maximum delivery time, and factors such as the average contact time with the warehouse per order. These KPIs create a visible relationship to the new implementations and the effects that they have on the company.

3.3 Multi-criteria decision-making

When comparing multiple warehousing systems, or multiple TPL providers, it is not about just considering a price difference. A lot of aspects come into play, which all are considered when making

a decision. For instance, the quality of the relationship between two parties, the locational effects of warehouse and many more.

3.3.1 MCDM methods

When making a decision on multiple characteristics, a multi-criteria decision-making method is considered. In a multi-criterion decision-making method is multiple conditions can be combined with ease. There are many different types of MCDM, short for Multi-Criteria Decision-Making, methods which all have their different benefits and shortcomings, and areas of application. According to Velasquez and Hester (2013) the following three techniques are best applicable in the areas of this research, logistics and supply chain: (1) Analytic Hierarchy Process and (2) Simple Multi-Attribute Rating Technique.

Analytic Hierarchy Process, AHP, is an easy-to-use method, and can easily be adjusted to bigger sized problems. The major characteristic of the AHP method is the use of pair-wise comparisons, which are used both to compare the alternatives with respect to the various criteria and to estimate criteria weights (Løken, 2007). AHP mainly revolves around the following steps (Vaidya & Kumar, 2006):

1. State the problem.
2. Broaden the objectives of the problem.
3. Identify the criteria that influence the behaviour.
4. Compare each element in the corresponding level and calibrate them on the numerical scale.
5. Perform calculations to find the maximum eigen value, consistency index (CI) and the consistency ratio (CR).
6. If the maximum Eigen Value, CI, and the CR are satisfactory, then the decision will be taken based on normalised values, otherwise it will repeat itself.

However, the problem is that there is a lot of interdependence between the criteria, which can lead to problems in evaluating the validity of the multiple criteria.

Simple Multi-Attribute Rating Technique is a relatively simple method. SMART allows for any type of weight assignment techniques, such as relative, absolute and more (Konidari & Mavrakis, 2007). This MCDM technique is proposed on the theory that each alternative possibility consists of some criteria that have value, and that each criterion have weights describing how important that criterion is (Siregar, Arisandi, Usman, Irwan, & Rahim, 2017).The function model for SMART is as follows, to maximise the practical value of an alternative to the company:

$$Maximise\ U_j = \sum_k w_k u_{jk}$$

$U_j =$ Utility function of alternative j
$w_k =$ Normalised weight for objective k
$u_{jk} =$ Scaled value for alternative j on dimension k
EQUATION 1 SMART FUNCTION

This formula thus gathers the maximum utility function of an alternative, which is calculated by multiplying each weight with the scaled value that for that particular weight.

3.3.2 Weighting methods

When applying MCDM methods, a company makes a decision on multiple aspects. When choosing a TPL warehouse, a company has to decide on many aspects, such as the financial costs, the experience, or the durability. However, which of the aspects is weighted as most important, can always differ between multiple companies. This can be the effect of their own visions, or the problems they have suffered in the past.

These differences in what a company finds important, have to be considered whenever a decision is made. To do so, weights can be introduced into MCDM. These weights represent the importance a company places on a certain subject. As mentioned in Section 3.3.1. the difficulty in the identification of the weights is that is mostly influenced by the decision makers' judgment and preferences. Therefore, the problem is that these weights can influence the validity of the outcomes. To prevent this from happening, a weight distribution method is chosen.

As visible in Figure 12, there are two types of appointing weights to MCDM: Compensatory and non-compensatory (Tzeng & Huang, 2011). In a compensatory approach, the assumption is made that within one alternative a high performance on one or more criteria can compensate a weak performance on another criteria. This means that within compensatory MCDMs, a poor experience of a TPL provider can be compensated when the company would prioritise the overall costs of the operations. The effect of this is thus that priorities are considered within the decision-making. Although a compensatory method is more cognitively demanding according to Tzeng and Huang (2011), we are looking for a method that is the most valid. Therefore, it can be interpreted easier to be able to look at priorities as it is easier to rank certain aspects, than to value them individually.

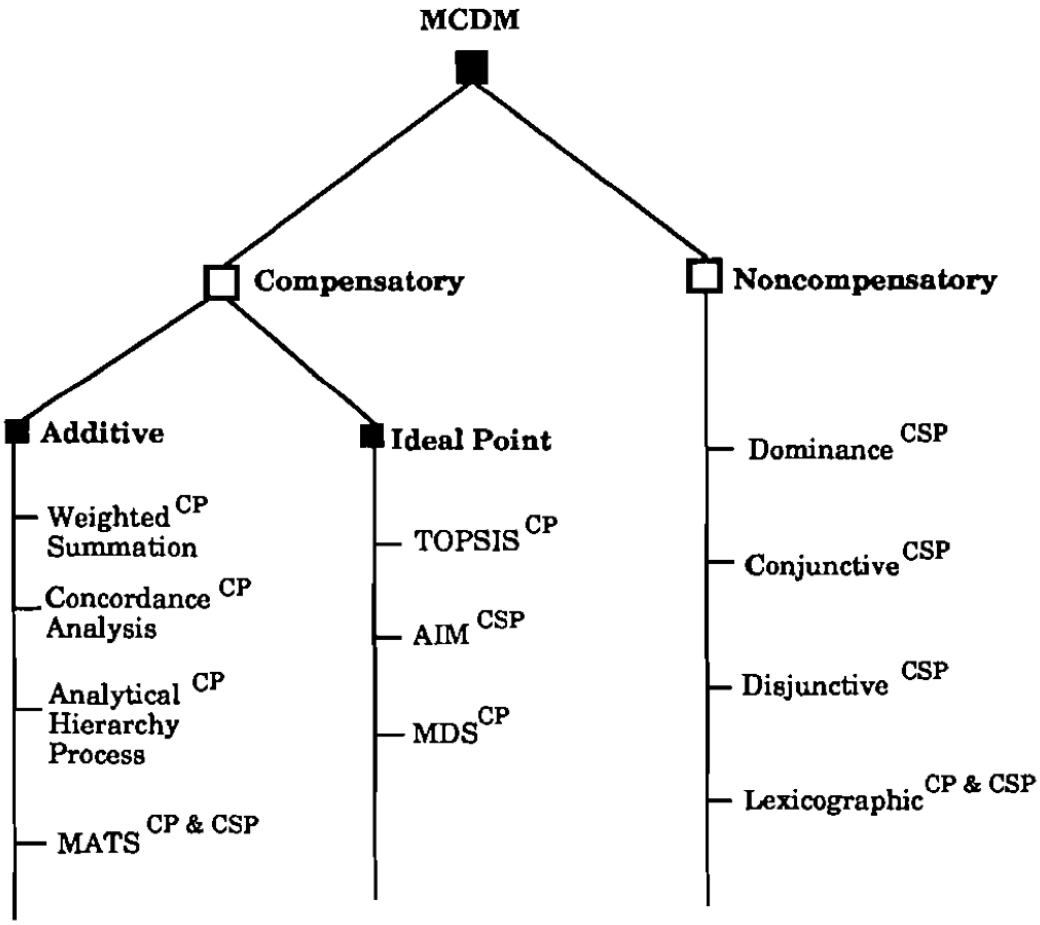

FIGURE 12 TYPES OF MCDM
(TZENG & HUANG, 2011)

A method of compensatory MCDM is the weighted summation method. This method is an additive technique in which the sum of all weights must equal one (Fishburn, 1967). In Equation 1 w_k is given a decimal value between zero and one. By weighing each criterion, the alternatives are given a priority. Although this method is not complex, the central element of this method is that all the elements of the decision table are easily normalised, before comparing them.

In our research on MCDM a method on comparing multiple alternatives of TPL was created. Each alternative of third-party logistics warehouses are considered with a similar technique, to prevent a bias in the decision-making. To do so, we have sent the questionnaires to the alternative companies in Section 3.4.

3.4 Questionnaires

During our research, we want to reach a high research population to validate the MCDM tool that we create. Therefore, an efficient method to reach the greatest number of third-party logistics warehouses are questionnaires. A form of questions in a questionnaire is the Likert scale. The range of the Likert scale captures the intensity of the respondents' feelings for the given item (Likert, 1932). The questions therefore range in the level of agreement between strongly disagree, to strongly agree. The range of this scale can be changed, which affects the intervals between the different levels of agreement. A typical problem with the Likert scale is that people often choose to give a neutral reaction (Brown, 2000). This can be prevented by giving an even number of options, so that the respondents must always pick a side. The advantages of this scale are that (1) the data can be gathered relatively quickly from large numbers of respondents, (2) they can provide highly reliable person ability estimates, (3) the validity of the interpretations made from the data they provide can be established through a variety of means and (4) the data they provide can be profitably compared, contrasted and combined with qualitative data-gathering techniques (Nemoto & Beglar, 2014).

The create a valid questionnaire there must be enough respondents. The more respondents within the research population can aim for a higher validity. For valid research a minimum of four respondents per population group is needed (Nemoto & Beglar, 2014). The level of validity can be tested with the following four types of validity: (1) Content validity, (2) face validity, (3) criterion validity and (4) construct validity (Roopa & Rani, 2012). Content validity can be achieved by having the judgement of another expert in the field, who agrees with the content of the questionnaire. Face validity is about whether the questions are interpreted in the right way. This can be achieved by interviewing the respondents with regards to their interpretation of the statements. Criterion validity is about whether the survey tests what it needs to test, and whether there are any external effects influencing the questions. And lastly the construct validity is about whether it conforms with currently already existing concepts or research.

Our research on questionnaires has concluded that we use a Likert scale. After we have received the results of the alternatives of TPL, an analysis is done on the effects that implementing TPL into the company of Flying Fish. To do so, we now focus on researching scenario analyses in Section 3.5.

3.5 Scenario analysis

While gathering the results of our research, we focus on implementing those results into the company of Flying Fish. To implement our analyses, a scenario analysis is used. A scenario is defined as a description of a possible future situation (Kosow & Gaßner, 2008). The aim behind scenarios is to generate orientation regarding future developments through an observation of certain relevant key factors. A scenario analysis is an analysis is thus a method to predict the behaviour and the consequences of certain modifications that are made in a business. Scenario analyses are known for describing behaviour from the users point of view (Hsia et al., 1994) . Applying this technique provides guidelines to build a cost-effective solution. According to Kosow and Gaßner (2008), a scenario analysis exists out of the following phases:

(1) In the scenario field identification, a problem is analysed. An overview of the situation is made, to create a clear view on some specific issue. (2) After that, a description follows, in which the key factors for the business and parameters are identified. (3) The focus is then brought on the effect that individual key factors can have on the characteristics of the scenario. (4) These individual key factors then are combined in the next step, to analyse how multiple individual parameters combined can

influence the scenario. (5) Then the further application of the scenarios is generated in the last step. There are multiple ways of analysing different scenarios. One way of analysing is to use simulation ((Liu et al., 2007). By simulating, an imitation of the real-world variables are used to imitate a possible process over time. The advantage of simulation is to generate a large amount of data (Chapuis, Calmon, & Jenson, 2018). This large amount of data improves the validity of the results, due to the increase of samples that are statistically used.

Using this technique in our study can provide great insights in the integration of TPL. A potential scenario are designed, while keeping in mind the priorities of the company. Another important factor is that it helps validating the research as well, which can increase the reliability and the validity of our research significantly.

3.6 Summary

In this theoretical framework we have elaborated on the concepts which are needed for our study. We considered the definition and the application of the following four important theories: TPL, Key Performance Indicators, Multi-Criteria Decision-Making, and Scenario Analysis. TPL gives the possibility to outsource the focus on the supply chain, to focus on other elements in a company. When choosing a TPL provider, there are six dimensions of selection criteria: (1) quality, (2) cost, (3) services, (4) performance metrics, (5) information system and (6) intangibles. The definition of KPIs are customizable business measures utilized to indicate the priorities of the company in measurable elements. A multi-criterion decision-making technique is proposed on the theory that each alternative consists of multiple criteria, and that each criterion has weights describing how important that criterion is. These weights are given a value using a compensatory method named weighted summation, which applies the rule that the total of all the weights equals one. This makes sure that priorities are measured between multiple weights. To consider every alternative of TPL warehouses, a Likert Scale questionnaire captures the intensity of the respondents' feelings for the given item. This scale makes sure every alternative is evaluated with the same technique. After the decision-making tool has chosen the right alternatives, the company that fulfils TPL with similar priorities as Flying Fish are evaluated and possibly implemented into the company of Flying Fish. To support this implementation a scenario analysis generates orientation regarding future developments through an observation of certain relevant key factors. A scenario analysis is thus a method to predict the behaviour and the consequences of certain modifications that are made in a business. Based on these theoretical concepts, our study focuses on creating a decision-making tool on TPL. In the current literature, there is not yet a focus on creating decision-making tools for a practical application. Therefore, this study is closing that gap, to improve future decision-making processes.

4. Decision-making tool

In the theoretical framework, we created a perspective on what knowledge was needed for creating a solution making tool. In this chapter, we are creating an MCDM tool that help Flying Fish find the right alternative of the third-party logistics warehouses. We first describe our expectations from this tool in Section 4.1. After that we go over all of the different dimensions that we have mentioned of the selection criteria Section 3.1, and we implement the criteria that subdivide these dimensions in Section 4.2. Lastly, we design the MCDM tool in Section 4.3.

4.1 Concept

To make a decision about the third-party logistics warehouse, we create a MCDM method. To do so utility values have to be computed as mentioned in Section 3.3.1. We create a tool which can help a company in finding a third-party logistics warehouse. The goal of this tool is to be generic, as it must be possible to apply this tool to any company seeking for TPLs. As mentioned in Section 3.1 there are six dimensions which we consider in this tool. In Section 4.2, we will divide these six dimensions into measurable criteria, that can be placed on a Likert scale. The concept of this tool is to be a guideline for companies on what criteria to consider while interviewing TPL providers. The process of positioning all these criteria into one tool is done subjectively by the opinion of the company. Whenever the sub-criteria are more difficult to measure, or whenever the information is not available within the TPL company, an estimation suffices in this tool.

4.2 Dimensions

In the decision-making process of a TPL provider there are a lot of factors to consider. There are six dimensions which are considered in terms of choosing a TPL provider, see Table 8. The goal of this research is to create a decision-making tool, which is used to choose between multiple alternatives for TPL providers. This tool considers all of the six important dimensions: (1) Quality, (2) Costs, (3) Services, (4) Performances, (5) Information Systems and (6) Intangibles. These dimensions are divided in multiple criteria, to make the tool more measurable.

4.2.1 Dimension 1: Quality

The quality of a TPL provider is important. According to Sink and Langley Jr (1997), quality is measured in three different criteria: Continuous improvements, ISO Compliance and KPI tracking.

- Considering continuous improvements, it is important to look at a company's past results in improving their quality, and their future projects and expectations when it comes to quality improvements. Whenever a company already has a high quality, the number of improvements in the past compensates the relatively low number on planned improvements.
- ISO compliance is a quality management system that ensures that companies are adhering to the requirements of ISO standards. The type of ISO management system that the company uses matters, as this implies a part of the level of quality management. Furthermore, it is noteworthy whether the TPL provider has an ISO certificate.
- Furthermore, to remain offering a high quality, it is essential for the company to be able to track their KPIs as narrow as possible. The method of tracking plays a big role, and are therefore considered, next to the responsiveness to those Key Performance Indicators. Whenever a company has great insights in their own information, the company has more control of remaining their quality.

In Table 9, the rating scheme for the first dimension is shown. The quality of a company is divided into multiple sub criteria, which are rated on a scale from one to five.

Dimension	Subcriteria	Scores 1	2	3	4	5
Quality	Number of improvements over the past	No improvements in the past year, quality decreased	No improvements in the past year	Some improvements in past year	Many improvements in past year	High number of improvments in past year
	Planned improvements	No planned improvements	Little planned improvements	Some planned improvements	Sufficient planned improvements	High planned improvements
	Number of ISO system	0 types of ISO compliances	Less than 3 types of ISO compliances	Less than 5 types of ISO compliances	Less then 7 types of ISO compliances	7 types of ISO compliances
	Compliance and certification?	Not ISO certified	-	-	-	ISO certified
	KPI tracking methods	No KPI tracking methods	Some KPI tracking method, not monitored	Some KPI tracking method, monitored	Many KPI tracking methods, not monitored	Many KPI tracking methods, monitored
	Responsiveness on KPI tracking	No responsiveness on KPI tracking	Little responsiveness on KPI tracking	Some responsiveness on KPI tracking	Sufficient responsiveness on KPI tracking	Perfect responsiveness on KPI tracking

TABLE 9 RATING SCHEME: QUALITY

4.2.2 Dimension 2: Cost

The costs of a TPL provider is important to take into consideration. The costs of the operations affect the balance sheet of both parties. The cost of the operation is measured in the price, in the continuity of cost reductions and in the cost control of value-added services.

- The price of the process is important. Both the holding costs and the costs for picking an order are considered, if the TPL provider performs those operations.
- Whether the company is continuously seeking for cost reductions for their prices is important, however, to decrease the influence of the exact moment in time of the measurement, when investigating the performance of the cost reductions, not only the current time is considered. Therefore, it is important to consider the percentage of cost reduction in the past, as well as the planned cost reduction.
- The cost control of value-added services are measured. The TPL warehouses consider the price versus satisfaction rate of their services. From the perspective of the customer, value added services facilitate more satisfaction although they are not the core activities of the provider. It is therefore considered whether the provider adds those services in cooperation with their customers. Whenever there is communication about which services are important between the TPL company and the customer, the value of these services improves.

In Table 10 these elements are considered in our rating scheme. Each individual sub criterion is rated on a scale from one to five.

Dimension	Subcriteria	Scores 1	2	3	4	5
Cost	Price of picking costs	More than double of the current picking costs	More than the current picking costs	Equal to the current picking costs	Less than the current picking costs	More than half of the current picking costs
	Price of holding costs	More than double of the holding picking costs	More than the holding picking costs	Equal to the holding picking costs	Less than the holding picking costs	More than half of the holding picking costs
	Percentage of cost reduction in the past year	Raised cost in the past year	No cost reduction in past year	More than 0 cost reduction in past year	More than 5 percent cost reduction in past year	More than 10 percent cost reduction in the past year
	Planned cost reductions	No planned cost reductions	Little planned cost reductions	Some planned cost reductions	Sufficient planned cost reductions	High planned cost reductions
	Collaboration with customers	No collaboration with customers	Low collaboration with customers	Some collaboration with customers	Sufficient collaboration with customers	Perfect collaboration with customers
	Price/satisfaction rate of customers	Lower than 45 percent price/satisfaction rate	Higher than 45 percent price/satisfaction rate	Higher than 60 percent price/satisfaction rate	Higher than 75 percent price/satisfaction rate	Higher than 90 percent price/satisfaction rate

TABLE 10 RATING SCHEME: COSTS

4.2.3 Dimension 3: Services

Choosing a TPL company is not only about the price of the operations. There are a lot of possibilities when it comes to extra services, such as the environmental benefits, reversed logistics or freight forwarding. Having these extra possibilities creates the opportunity to add value for the customer.

- As mentioned in Section 4.2.2, value added services can have significant influence for the customer. The number of value-added services is a great measure of the effort of the provider. Furthermore, the similarities in what the customer wants and what the provider supplies make a great deal in scoring the services, which is represented with the customer satisfaction rate.
- The communication between a customer and the provider is an important factor when it comes to the communication between the actors in the supply chains, as whenever errors occur, the client is able to get assistance from the TPL company. The way a TPL warehouse handles their customer support for both logistical questions regarding documents and management are considered when making a decision between alternatives.
- Whenever a customer needs help, the TPL company replies within a given timeframe that is preferred by the company. To prevent the companies from having different expectations on that timeframe, the average response time and the late response rate is needed.

- To gather information on the service effectiveness both the customer satisfaction rate and the rate at which customers return with the same question is needed. Whenever the service effectiveness is high, this return rate would decrease.

In Table 11 we quantify these sub criterions on a scale from one to five. The performance of the TPL warehouse is thus evaluated by this scheme.

Dimension	Subcriteria	Scores 1	2	3	4	5
Services	Number of value added services	No value added services, no customization possible	Less than 3 value added services, little customization possible	Less then 5 value aded services, some customization possible	Less than 10 value added services, sufficent customiztion possible	More than 10 value added services, perfect customization possible
	Pleasure of value added services	No satisfaction of value added services	Little satisfaction of value added services	Some satisfaction of value added services	Sufficient satisfaction of value added services	Perfect satisfaction of value added services
	Support regarding logistics	No support regarding logistics	Little support regarding logistics	Some support regarding logistics	Sufficient support regarding logistics	Perfect support regarding logistics
	Support regarding management	No support regarding management	Little support regarding management	Some support regarding management	Sufficient support regarding management	Perfect support regarding management
	Timespan	Within 50% of expectations of timespan	Within 40% of expectations of timespan	Within 30% of expectations of timespan	Within 20% of expectations of timespan	Within 10% of expectations of timespan
	Late response percentage	50 percent or more late response	Lower than 50 percent late response	Lower than 35 percent late response	Lower than 20 percent late response	Lower than 10 percent late response
	Satisfied customer rate	Lower than 60 percent customer satisfaction	More than 60 percent customer satisfaction	More than 70 percent customer satisfaction	More than 80 percent customer satisfaction	More than 90 percent customer satisfaction
	Return with same problem rate	Higher than 50 percent return rate	Lower than 50 percent return rate	Lower than 35 percent return rate	Lower than 20 percent return rate	Lower than 10 percent return rate

TABLE 11 RATING SCHEME: SERVICES

4.2.4 Dimension 4: Performance

The performance of a TPL provider is measured when making a decision. Measuring how the operations run and whether they are executed in the way as expected, potentially prevents the TPL company to oversell itself.

- The problem-solving capability is measured to prevent crises to develop. To measure this, the evaluating processes on the performance of the company is assessed. Whenever the processes within a company can constantly be evaluated, the processes prevent problems from occurring in early stages. Additionally, the approach that is used whenever a problem does occur, and how the resolution is planned is important.
- Accuracy in the documents has an important role in preventing miscommunications to occur. Therefore, the highest level of similar language is assessed. Additionally, a useful structure in the documents is beneficial to both parties.
- Transportation safety is about the safety of the people and about preventing any damages to occur to the product. In TPL, the product can be transported a lot and therefore, the measures that the company takes in terms of safety need to be considered. Additionally, the approach is important to assess how a company responds in terms of liability and warranty when damages occur.
- The shipment error rate is measured in two factors: The number of shipments the company has dealt with in the past, and the percentage of them having errors.
- When it comes to the delivery time, there is research whether the vision of the parties align. This means whether the desired delivery time is the same for both companies. Furthermore, the percentage of which the orders are delivered within that given timeframe is needed.

In Table 12 the method of quantifying the performance of the company is visualised. Each sub criterion is rated for the purpose of aligning the processes to the priorities of Flying Fish.

Dimension	Subcriteria	Scores 1	2	3	4	5
Performance	Evaluating process	No evaluating processes	Little evaluating processes	Some evaluating processes	Sufficient evaluating processes	Perfect evaluating processes
	Planning process	No planning processes	Little planning processes	Some planning processes	Sufficient planning processes	Perfect planning processes
	Highest level of similar language	No similar language	A1 or A2 level of similar language	B1 or B2 level of similar language	C1 or C2 level of similar language	Same native language
	Structure in documents	No structure in documents	Little structure in documents	Some structure in documents	Sufficient structure in documents	Perfect structure in documents
	Warranty procedure	No warranty procedure, full liability for the customer	Little warranty procedure, high liability for the customer	Some warranty procedure, medium liability for the customer	Many waranty procedures, low liability for the customer	Perfect warranty procedures, no liability for the customer
	Safety procedures (preventing danger)	No safety procedures	Little safety procedures	Some safety procedures	Sufficient safety procedures	Perfect safety procedures
	Percentage of errors	Higher than 20 percent error rate	Lower than 20 percent error rate	Lower than 10 percent error rate	Lower than 5 percent error rate	Lower than 1 percent error rate
	Number of shipments	Less than 25 shipments per month	More than 25 shipments per month	More than 50 shipments per month	More than 75 shipments per month	More than 100 shioments per month
	On-time delivery rate	Lower than 45 percent on-time delivery rate	Higher than 45 percent on-time delivery rate	Higher than 60 percent on-time delivery rate	Higher than 75 percent on-time delivery rate	Higher than 90 percent on-time delivery rate
	Delivery time promise	More than 50% slower delivery time	50 percent slower delivery time	25 percent slower delivery time promised	Equal delivery time promised	Faster delivery time promised

TABLE 12 RATING SCHEME: PERFORMANCE

4.2.5 Dimension 5: Information systems

The information systems of a company have influence in the decision for TPL. Organised information systems often imply a structured business, in which less errors are made.

- Data integrity and reliability is measured on the approach of the data management and on the falsification of the data. As this metric is more complex to measure, the measurements on how the falsification is prevented within the company suffices on suggesting how the company is dealing with this. Whenever data is incomplete, the company anticipates making it possible to report this.
- Network security is tested on the security procedures the TPL company has. When a company anticipates dealing with high security, the failure rate of the network is most likely to decrease.
- To measure the stability of the network of the provider, we study the current network infrastructure of the company, and the strength of it. Furthermore, we analyse the network tests that the company has done to assure the stability.
- A functional scalability of IT infrastructure suits the information systems to the right size for a company. The possibility of down- and upscaling the systems can make sure that the technology is the right fit for the company. Therefore, the current IT capability matters in investigating the performance of the company as well.

In Table 13 the rating scheme of the information systems are visualised. Each criterion is subdivided into multiple measures, which quantify the performance of the company.

Dimension	Subcriteria	Scores				
		1	2	3	4	5
Information system	Data management	No data management	Little data management	Some data management	High data management	Perfect data mangement
	Falsification of data	Incomplete data reporting, failure to follow a method	Some of incomplete data reporting, little methods	Sufficient data reporting, sufficient methods	High data reporting, high level of methods	No incomplete data reporting, perfect methods
	Security procedures	No security procedures	Little security procedures	Some security procedures	Sufficient security procedures	Perfect security procedures
	Failure rate	Failure rate higher than 50%	Failure rate lower than 50%	Failure rate lower than 35%	Failure rate lower than 20%	Failure rate lower than 10%
	Network infrastructure	Insufficient network infrastructure	Below average network infrastructure	Sufficient network infrastructure	Above average network infrastructure	Perfect network infrastructure
	Test procedures	No test procedures	Some test procedures	Some test procedures	Sufficient test procedures	Perfect test procedures
	IT infrastructure capability	Insufficient infrastructure capabilities	Below average infrastructure capabilities	Sufficient infrastructure capabilities	Above average infrastructure capabilities	Perfect infrastructure capabilities
	Scalability	No scalability of IT infrastructure	Low scalability, not much attention paid to the size of the company	Medium scalabality, could be scaled better for the company	High scalability of IT infrastructure, could be fitted better to the company	High scalability of IT infrastructure, fitted perfect to the company

TABLE 13 RATING SCHEME: INFORMATION SYSTEMS

4.2.6 Dimension 6: Intangibles

The intangibles of the company are variables which do exist, but cannot be touched, exactly described nor given an exact value. However, they do have influence on the decision and are therefore analysed via the following concepts. By coming up with the characteristics of the intangibles, the concepts are considered in the MCDM as well.

- Although the experience of the company itself is intangible, we are measuring this criterion according to the numbers of years that they have worked as a TPL provider. Furthermore, the number of companies that are a customer of the TPL provider can imply that the company has more experience: A higher number of companies implies a higher level of experience.
- The global scope of the TPL warehouse is measured with the number of logistical contacts the company has. These contacts can represent the network of the company, for which having a bigger network would create a better environment to fulfil the logistical tasks. For example, having logistical contacts in every country within the European Union insists a better accessibility to reach those countries. However, the number of contacts of the TPL provider that are located in the countries in which the customer needs those the most is important, as this accessibility focuses on the specific demand of the company.
- The geographical location of the company matters, as a location in a not ideal location can imply extra shipping costs in our case. Therefore, the distance from the centre of gravity of the customer base where it is needed is calculated. Additionally, it can be important that the warehouse is located at a location which is accessible for the customer itself. Therefore, the location from the general office of the customer is considered in the MCDM.

- The financial stability of the company is measured as well. It has negative influences whenever there is little stability, and it can influence the work of both parties. Therefore, the Altman's Z-score, which represents the stability of the company, is calculated for the company. The Altman's Z-score is a well-known failure prediction model (Altman, Iwanicz-Drozdowska, Laitinen, & Suvas, 2017). Furthermore, whether the company anticipates on how they deal with financial risks is important.
- To gather the thoughts of the feeling of the customer, we gather the emotions regarding the people of the TPL warehouse on the Likert Scale, as described in Section 3.4. If this feeling is right, this plays a beneficial role in the collaboration between the parties. Furthermore, the atmosphere is represented as well.

In Table 14 visualises the measurements of the intangibles at an alternative of TPL. Via these measurements, the performances of these intangibles are quantified.

Dimension	Subcriteria	Scores				
		1	2	3	4	5
Intangibles	Years of experience	Less than one year experience	Less than two years of experience	Less than 3 years of experience	Less than 5 years of experience	More than 5 years of experience
	Number of customers	No other customers	Less than three other customers	Less then 5 other customers	Less than 10 other customers	More than 10 other customers
	Z-score	Z-score lower than 1.8	-	Score between 1.8 and 3.0	-	Score higher than 3.0
	Anticipation when in risk	No anticipation when in risk, no attention paid to situation.	Little anticipation when in risk, no real attention paid to situation	Normal anticipation when in risk, evaluate risks sometimes	Good anticipation when in risk, much appention paid to risks	Perfect anticipation when in risk, always considering possible risks.
	Atmosphere	No atmosphere, clashing cultures, different vision in terms of business	Mediocre atmosphere, different cultures, low similarity in visions	Similar culture, unclear vision in terms of business, no impressive atmosphere	Many similarities between culture and vision, above average atmosphere.	Same culture and vision, very pleasent atmosphere
	People	Conflicting people will deteriorate the logistics of the company	Different type of people, will most likely influence the logistics negatively	Mediocre, will not have a negative nor positive influence, not very formal	Kind people, will have positive influence, easy communication, formel attitude	Pleasent people, good in communication, professional attitude
	Location from customers	Location score equal or higher than 50%	Location score lower than 50%	Location score lowe than 35%	Location scoe of less than 20%	Location score of less than 10%
	Location to office	Travel time of more than 4 hours	Travel time lower than 4 hours	Travel time lower than 3 hours	Travel time lower than 2 hours	Travel time lower than 1 hour
	Logistical contacts	Very little logistical contacts, no built long-term relationships with other parties	Little logistical contacts, relationships with other parties are not exclusive	Sufficient logistical contacts, building on relationship with other parties	Many logistical contacts, partners, trusted relationships among multiple	Many exclusive relationships with other countries, exclusive distribution channels.
	Contacts in the areas where needed	No contacts in the countries where the customers are located	Little contacts in the countries where needed, options to expand the network	Contacts in the countries where needed, little new contacts have to be build	Contacts in the countries where needed, network can grow when needed	Contacts in more countries than where the customers are located

TABLE 14 RATING SCHEME: INTANGIBLES

4.3 Explanation of design tool

After we have quantified all the performances of an alternative of TPL, we can enhance our research to aligning these performances along the priorities of Flying Fish. As mentioned in Section 3.3.2, we define the weights by a method called the weighted-summation rule. This means that the total sum of all weights equals one, for which the choosing company thus has to compensate one dimension for another. As visualised in the tool in Table 15, the left side of the tool contains the weights that are assigned by the company. On the right side of Table 15 the criteria functions, generated with the specifications in Section 4.2, are represented.

Multi-Criteria Decision Making Tool					
Weight calculation company			**Weight calculation 3PL provider**		
Quality	Continuous improvements		Quality	Continuous improvements	
	ISO compliance			ISO compliance	
	KPI tracking			KPI tracking	
Costs	Price		Costs	Price	
	Continuous cost reduction			Continuous cost reduction	
	Cost control of value added services			Cost control of value added services	
Services	Value added services		Services	Value added services	
	Customer support service			Customer support service	
	Responsiveness			Responsiveness	
	Service effectiveness			Service effectiveness	
Performance	Problem solving capabilities		Performance	Problem solving capabilities	
	Document accuracy			Document accuracy	
	Transportation safety			Transportation safety	
	Shipment error rate			Shipment error rate	
	On-time delivery			On-time delivery	
Information system	Data integrity		Information system	Data integrity	
	Network security			Network security	
	System stability			System stability	
	IT infrastructure scalability			IT infrastructure scalability	
Intangible	Experiance		Intangible	Experiance	
	Financial stability			Financial stability	
	Emotion			Emotion	
	Geographical location			Geographical location	
	Global scope			Global scope	

TABLE 15 MULTI-CRITERIA DECISION-MAKING TOOL

After inserting all this information, the MCDM tool is able to find the best alternative of TPL. This is done by multiplying the left and the right side of Table 15. The weights of Flying Fish are multiplied with the performances of TPL warehouses, after which we find the utility function as shown in Section 3.3.1. After calculating the utility function, the company with the highest utility function is the best alternative for the company.

4.4 Summary

During this chapter, we covered the different aspect of the design of the MCDM tool. The tool functions based on the subjective opinion of the choosing party and guides that party through all the important elements to consider when choosing a TPL relationship. Each of the six dimension described by Sink and Langley Jr (1997) can be divided into multiple sub-criteria. Each of these sub-criteria is scored in the generated tool for the criteria function. These scores are directly inserted in the MCDM tool, in which they are multiplied with the weights that are given by the company. As this is a generic tool, we now investigate the application of this tool to our case.

5. Solution Design

In this chapter, we focus on applying the MCDM tool to the company of Flying Fish. We first focus on distributing the weights that the company gives the dimension in Section 5.1. After that, we focus on gathering information from TPL warehouses for our research in Section 5.2, after which we validate this information in Section 5.3. We apply this information to our decision tool in Section 5.4.

5.1 Weight distribution

As discussed in Section 3.3.2 a compensatory weighing process is used to evaluate the priorities between the six dimensions of Sink and Langley Jr (1997). When the managing director of Flying Fish, the dimensions with their criteria were presented. After discussing the criteria and aligning them with the priorities of the company, the weights for the criteria are established.

As described in Section 4.2.4, the company weights the performances of a potential TPL the highest. Due to the fact that in the current processes the performance of Warehouse X is relatively low, this is something the company wants to trust on. As mentioned in Section 1.3 the shipment error rate currently is high due to the priorities of Warehouse X. This often causes delays in the shipment, which has the effect of the high delivery times of the products at the company. The ability to have a warehouse with a high-performance rate indicates that the company can focus on the other core functions of their business.

The costs of the services that are provided by a TPL provider as described in Section 4.2.2 are rated as the second most important dimension of Sink and Langley Jr (1997). As the company distinguishes themselves in having the lowest prices in the market of e-foils, they have to keep the costs of their processes as low as possible. Having low holding costs, packing costs and transportation costs would improve the feasibility of their operations.

The third rated dimension as described in Section 4.2.3 is the services that are provided by the TPL provider. Mainly the value-added services add significance and ease to the operations of Flying Fish eFoils. As the current management systems at the company lack insights in some aspects of the company, having a company which would well-organise all their data would potentially improve the operations at the company.

Furthermore, the dimension of the quality of the TPL company, which are elaborated in in Section 4.2.1 is rated below the services. Having an internal quality in which there is a continuous quest for improvements, implies of a healthy and reliable structure for a TPL warehouse to have a close relationship with for Flying Fish eFoils. The intangibles, as mentioned in Section 4.2.6 are rated as the fifth dimension, as the location and the cultural differences influence the relationship between the companies. However, as Flying Fish has the priority to improve their warehousing on the aspects of performance and costs, partially sacrificing the intangibles would suffice.

The information system from Section 4.2.5 of the TPL would have the lowest priority according to the company of Flying Fish. Table 16 contains the compensatory weights given by the managing director of the company. Visible in this table are the priorities that are concluded from the interview and are used throughout the procedure of using the decision-making tool that was constructed in Section 4.3. To perform the calculations in the MCDM tool, we evaluate the performance and the priorities of the company with these weights, in order to gain knowledge on the similarity of expectations between both parties. The managing director had the option to divide 100 scoring points on the six dimensions to make it more tangible, which will then be converted to the maximum score of one as mentioned in Section 3.3.2.

Dimension	**Compensatory weights**
Quality	12
Costs	26
Service	18
Performance	30
Information system	5
Intangibles	9

TABLE 16 COMPENSATORY WEIGHTS OF THE DIMENSIONS

5.2 Warehouse data

To choose a TPL warehouse, data is collected on multiple warehouses. As mentioned in Section 2.2, Flying Fish currently have had their sales in 32 different countries across the globe. As Flying Fish is trying to reduce their warehousing costs, the fact that the sales are spread over multiple countries implies that a new warehouse for Flying Fish' company does also not have to be based in the Netherlands. A survey has therefore been sent to 68 different TPL warehouses, which were found on the internet, among the top five countries containing the most sales of Flying Fish within the centre of Europe. In Table 17 it is shown that the total response rate of this survey was 54 percent. In this survey, multiple questions that are in relationship to the different dimensions in our tool have been examined. These subjects are enquired for the purpose to compare the priorities of Flying Fish along with these warehousing companies.

	Number of companies contacted	**Rate of response**
The Netherlands	18	0.61
France	13	0.38
Spain	12	0.50
Germany	16	0.69
Poland	9	0.44

TABLE 17 SURVEY RESPONSE RATE

In Figure 13 the priorities per country are listed. The average rate of the priorities among the dimensions are displayed listed on a scale from one to six. There are some patterns noticeable when considering the priorities of the respondents. It is clear from the responses, that the TPL do generally not prioritise their information systems, as this is on average the lowest rated dimension for each country. Furthermore, the Netherlands and Germany are the two countries which focus the most on their performances, as opposed to Spain and Poland which focus more on the costs of their operations.

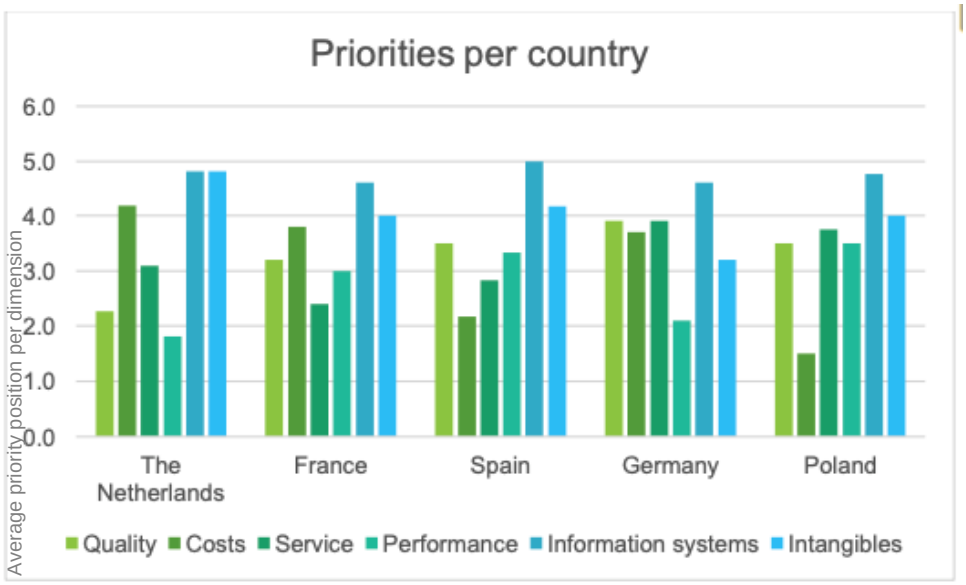

FIGURE 13 SURVEY RESPONSES: PRIORITIES PER COUNTRY

5.3 Data validation

To continue with our research, we first validate the data collected from our survey. As mentioned in Section 3.4, the validity of this data is implicated by a couple of entities, from which the first one the number of respondents is for this questionnaire. As mentioned in Section 3.4, there is a minimum of four respondents per population group, which was validated with Table 17. Furthermore, in our research we transparently constructed the questionnaire around the knowledge of experts in their literature studies, which proves the content validity of our research. The face validity is partially confirmed during the interviews that were taken with a few respondents is. Additionally, also a final question was introduced in which the TPL warehouses have to summarise their priorities. This summary was then compared to their answers in the questionnaire, to confirm the level of face validity. The criterion validity is approved due to the fact that priorities about the performance of the company are asked, in which we are looking for the external factors that generate the differences of the answers between multiple respondents. Furthermore, the methods of creating this questionnaire imply that the right criteria are tested. And lastly, we validate the construct validity of the concept partially as it aligns with the articles of similar studies from Large and Kovács (2001) on the German TPL and from Núñez-Carballosa and Guitart-Tarrés (2011) on the TPL in Spain.

5.4 Summary

To use the MCDM tool that we have constructed in Chapter 4, all the information that is needed for that process was gathered. To summarise, the priorities of the company of Flying Fish eFoils in setting up a new relationship with a TPL warehouse were recorded during an interview. The highest priorities are the dimensions of the level of performance and the level of costs of a TPL provider. Additionally, a survey was held with 68 TPL warehouses amongst the top five countries of sales of Flying Fish eFoils. After the validation of this data, all the information needed for the tool is existent.

6. Results

In Section 5.1 we have gathered the weight distribution selected by the staff of Flying Fish, and in Section 5.2 we have gathered all the data from multiple TPL warehouses within multiple countries in Europe. With this information, we can now fill in this information in the MCDM tool which we generated in Section 4.3.

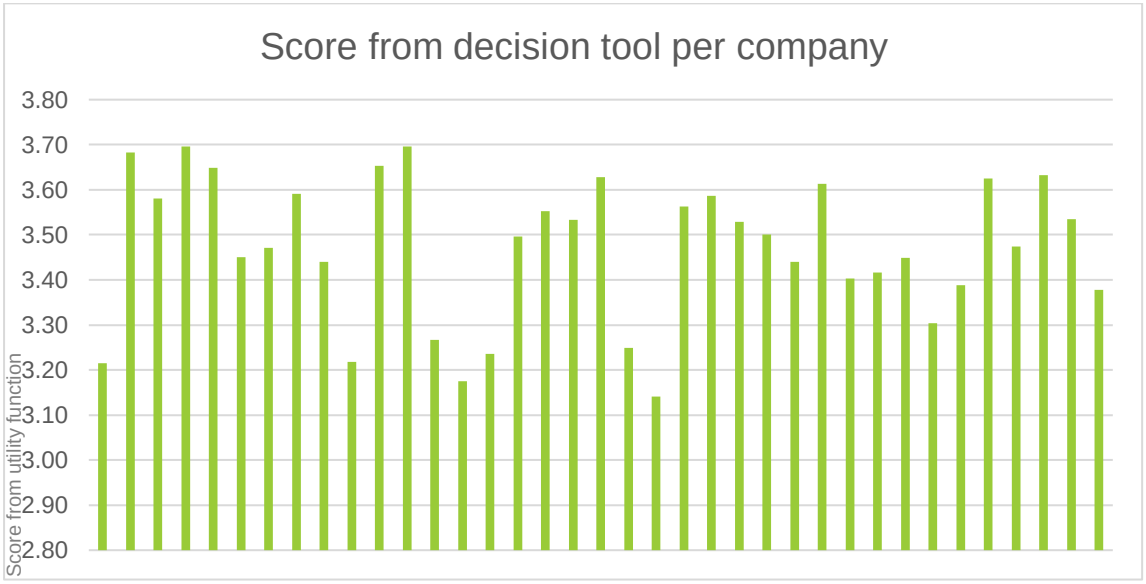

FIGURE 14 COMPANY SCORES FROM DECISION TOOL

After completing the calculations from our decision-making tool, each individual TPL warehouse receives a grade, which are visualised in Figure 14. For our research, we are seeking a TPL warehouse that has resemblances in the priorities compared to the priorities of Flying Fish, we start to investigate on the two companies with the most similarities, measures by the SMART function model mentioned in Section 3.3.1. These companies are verbally interviewed to gather the information needed for our scenario analysis. We elaborate more on these two companies, which we refer to as Warehouse Y and Warehouse Z.

6.1 Warehouse X

To validate the result of our research, we observe the results of the current warehousing system. Although the warehouse does not classify as a TPL warehouse, subjecting them to this research supports in pointing out the improvements that are found.

After interviewing the management of the current warehouse of Flying Fish eFoils, the information needed to fill in the MCDM tool was collected. As shown in Table 18, Warehouse X receives a low score on the service and quality dimensions. This can be clarified due to the fact that the company of Warehouse X does not have the core function of being a warehouse. Therefore, the quality of the value-added services is below average. Warehouse X indicates that it focuses on being able to deliver their services at a low cost for Flying Fish eFoil, as the company only rents a relatively small space inside their warehouse. The error rate of order is approximately nine percent.

Dimension	Criteria scores
Quality	2.67
Cost	3.17
Services	2.13
Performance	3.20
Information systems	3.57
Intangibles	3.20

TABLE 18 CRITERIA SCORES: WAREHOUSE X

6.2 Warehouse Y

Warehouse Y is a TPL provider based in Germany. The company is known for having a large network and is mostly branded as a logistics company throughout the whole of Europe. Although the core function of their business is transporting goods on request, they are operating a TPL since the past six years. As visible in Table 19 Warehouse Y mainly distinguishes themselves by the performances and the quality of their warehousing functions. The company has got a lot of value-added services, which can be personalised by every customer. Per stacking rack, which can contain up to four e-foils, the holding costs are up to 25 euros per month. The packing and labelling of the orders costs €120 per hour. From experience, we know that packing an order on average takes ten minutes, so the packing costs can be approximated at €20 per order. The error rate at Warehouse Y is 1.8 percent.

Dimension	Criteria scores
Quality	4.33
Cost	2.83
Services	4.75
Performance	4.20
Information systems	4.25
Intangibles	4.30

TABLE 19 CRITERIA SCORES: WAREHOUSE Y

6.3 Warehouse Z

Warehouse Z is a TPL provider based in Spain. The company is relatively young but focuses on providing a high level of service while maintaining low costs. The company has always been a TPL Warehouse and has focused on their value-added services. The low costs are a result of a continuous process of reducing the expenses and by a constant evaluation process together with the customers. Warehouse Z holds products in stacking racks, which can stack up to three boards, for a cost of €12 per month. Their packing and labelling costs are simplified to a fixed price of €14 per order independent of the size of the order, or €55 for handling the inventory per hour. The error rate at Warehouse Z is 3.4 percent. In Table 20, the criteria scores are shown.

Dimension	Criteria scores
Quality	4.00
Cost	4.33
Services	4.38
Performance	4.00
Information systems	3.57
Intangibles	4.00

TABLE 20 CRITERIA SCORES: WAREHOUSE Z

6.4 Summary

To summarise, the results of three warehousing companies are analysed through an extensive interview. Warehouse X is analysed further in this research to validate the improvements that this study aims for. The other two warehouses, Warehouse Y and Warehouse Z were selected on having the highest outcome of our decision-making tool. These warehouses were then interviewed verbally, to then evaluate their performances. Warehouse Y is a warehouse based in Germany which is known for being a transportation company throughout the whole of Europe and has started with TPL warehousing for six years. This warehouse mainly distinguishes themselves by the performances and the quality of their warehousing functions. This comes at the costs of the price of the services. Warehouse Z is a relatively young TPL provider and focuses on the low costs of their services. Warehouse Z is based in Spain.

7. Implementation

To answer the main research question that was stated in Section 1.5.1, we are generating an implementation plan on the findings during this research. The two companies that resulted with the highest utility function in Chapter 6 are two different types of companies. Therefore, we first focus on calculating the costs of the different options of warehouses that were the result of our MCDM tool in Section 7.1, after which we focus on interpreting these costs in Section 7.2. Lastly, we focus on the implementation plan for the upcoming years of the business of Flying Fish eFoils in Section 7.3

7.1 Cost calculation

This research is based on how to decrease the warehousing risks of Flying Fish eFoils while introducing a TPL warehousing system, we focus on the differences in costs of the three alternatives that were given in Chapter 6. The costs of warehousing can be scheduled into three different categories: Holding costs, service costs and transportation costs.

7.1.1 Holding costs

When considering the holding costs, the average inventory of Flying Fish eFoils is considered. In Section 2.5.3, the average inventory of the e-foil boards was 72.5 in 2021. As the expectation is that the company would want to increase their sales with fifty percent, the assumption is that the average inventory increases proportional. This is based on the assumption that the management system of the company does not change and that the costs of importing the goods from China do not change as well. As mentioned in Section 2.2, new inventory is not ordered from China until Flying Fish is currently selling to their customers while having shortages. When this happens, a bulk of e-foils are ordered, which is similar to the process of the inventory management in 2021. Therefore, by 2022 FFF has an average inventory of 108.75 boards. The comparison is made in Table 21.

	Warehouse X	**Warehouse Y**	**Warehouse Z**
Holding costs	Holding costs of €3.33 per board per month. Expected holding costs in 2022: $108.75 * 12 * €3.33 = €4,345.65$	Holding costs of €6.25 per board per month. Expected holding costs in 2022: $108.75 * 12 * 6.25 = €8,156.25$	Holding costs of €4.00 per board per month. Expected holding cost in 2022: $108.75 * 12 * 4 = €5,220.00$

TABLE 21 COMPARISON BETWEEN 3 WAREHOUSES: EXPECTED HOLDING COSTS

As visible in Table 21, the holding costs of Warehouse X are significantly lower than the holding costs of the other two companies. This result was expected, as in Section 6.1 we explained that Warehouse X is focussing on the low costs for Flying Fish. Furthermore, the low level of these costs can be explained by the low number of value-added services at Warehouse X. In contrast to Warehouse Y and Warehouse Z, Warehouse X do not focus their core business on being a warehouse for other companies. Additionally, this explains the low costs, as it is an extra income above their general business. The costs of Warehouse Y are much higher than the costs of Warehouse Z, which can be explained by their expertise in value-added services and their performances in general.

7.1.2 Service costs

When considering the service costs, there are multiple aspects to calculate: Unpacking costs, packing costs and costs of errors. The packing costs of ingoing orders happens when Flying Fish is increasing

their inventory after ordering goods from China. After these boards are delivered, the containers have to be unpacked. According to Flying Fish eFoils, the unloading of these containers takes approximately one hour per fifty boards, including account management of the inventory. In Section 2.1 we calculated the yearly demand of the product in 2021 to be 415 boards in total, distributed over 215 different orders. This implies that the demand for 2022 is expected to be 623 boards, according to their expected growth of 50 percent. The packing costs of the outgoing orders of the year 2021 was calculated in Section 2.5.5. As there are expected to be 322.5 different orders in the year 2022, we can compute the packing costs of outgoing orders accordingly. The costs of errors are related to the rate of errors at the company and the time that is spend. The costs are shown in Table 22.

	Warehouse X	**Warehouse Y**	**Warehouse Z**
Unpacking costs	Warehouse X does not unload the containers. When emptying a container, the company needs five employees with an average income of €20 per hour. Therefore, the expected costs are $\frac{623}{50} * €100 = €1{,}246.00$	Unpacking costs of €120 per hour. Expected unpacking costs in 2022: $\frac{623}{50} * €120 = €1{,}495.20$	Unpacking costs of €55 per hour. Expected unpacking costs in 2022: $\frac{623}{50} * €55 = €685.30$
Packing costs	Current packing costs: €,4331. Expected packing costs in 2022: $€4{,}331 * 150\% = €6{,}496.50$	Packing costs of €20 per order. Expected packing costs in 2022: $322.5 * €20 = €6{,}450.00$	Packing costs of €14 per order. Expected costs in 2022: $322.5 * €14 = €4{,}515.00$
Costs of errors	The error rate at 9.0 percent. Time for fix: 3 hours. Expected costs of error in 2022: $0.09 * 322.5 * 3 * 20 = €1{,}741.50$	The error rate is 1.8 percent. Time for fix: 0.15 hours. Expected costs of error in 2022: $0.018 * 322.5 * 0.15 * 120 = €104.49$	The error rate is 3.4 percent. Time for fix: 0.2 hours. Expected costs of error in 2022: $0.034 * 322.5 * 0.2 * 55 = €120.62$

TABLE 22 COMPARISON BETWEEN 3 WAREHOUSES: EXPECTED SERVICE COSTS

In Table 22, the service costs of the three warehouses are calculated. Firstly, the packing costs of incoming of warehouse Z are the lowest, as their hourly salary is relatively low in comparison to Warehouse Y. The major dissimilarity with Warehouse Z is the fact that Warehouse X does not process incoming order. Although the packing costs of outgoing orders of Warehouse X and Warehouse Y are relatively similar, warehouse Z has the lowest price on processing outgoing orders. Lastly, the costs of errors at Warehouse X is remarkably high, due to the higher error rate and the fact that the employees of Flying Fish often have to fix these errors themselves.

7.1.3 Transportation costs

To calculate the transportation costs, the only difference that we can consider is the location of the warehouses. As mentioned in Section 2.5.7, the costs for transportation per kilometre differ between transportation by air and transportation by road. Air transport costs €0.29 per kilometre while road transport costs €0.36. To increase the validity in calculating the costs of a year of transportation, we

simulate 323 orders with the destination of those orders according to the probability of those destinations of their demand of 2021. As mentioned in Section 3.5, in simulation real-world variables are used to imitate a possible process over time. We calculate the distance to the middle point of the country of our potential warehouses, and the middle point of the country of destination. We also distinguish the countries with their preferred shipment type. In Appendix A, the information that is needed for this simulation is shown. During this simulation, we draw a random number from a uniform distribution between zero and one which corresponds to the cumulative probability of the countries to which Flying Fish eFoils provides their product. We create a code in VBA, which randomises the destinations where the orders are shipped to in our simulation. We repeat this simulation ten times, to increase the validity of the numbers that are used. The results of this are shown in Table 23.

	Warehouse X	**Warehouse Y**	**Warehouse Z**
Total costs Road	€ 89,365.72	€ 90,270.61	€ 172,629.61
Total costs Air	€ 51,210.03	€ 49,446.02	€ 50,357.89
Total costs	€ 140,575.74	€ 139,716.63	€ 222,987.50

TABLE 23 COMPARISON BETWEEN 3 WAREHOUSES: EXPECTED TRANSPORTATION COSTS

In Table 23 the expected transportation costs of the three warehousing companies are compared. The total costs of warehouse Z are significantly higher than those of the other two warehousing companies. This is explained due to the decentralised location of Warehouse Z in Spain. It does not align with the centre of gravity of the sales of Flying Fish.

7.1.4 Total costs

The total costs of the operations are provided in Table 24. As visible, the costs of warehousing of Warehouse Z are significantly lower in comparison with Warehouse X and Warehouse Y, however, due to the less preferred location of the warehouse, it is expected that this alternative would cost an extra €80,000 when comparing the transportation costs. When considering all the costs of the alternatives warehousing including the transportation costs, the charges of Warehouse X are the least expensive. As mentioned in Section 6.1, the warehouse focuses on lowering the rental costs of their warehouse for Flying Fish eFoils. However, as visible in Table 24, these costs are almost compensated by the costs for Flying Fish that is incurred due to the errors that are made when packing and labelling the orders. Therefore, to increase their customer satisfaction and to decrease the average lead time of an order that the customer makes, the other alternatives are considered.

	Warehouse X	**Warehouse Y**	**Warehouse Z**
Holding costs	€ 4,345.65	€ 8,156.25	€ 5,220.00
Packing costs of incoming orders	€ 1,246.00	€ 1,495.20	€ 685.30
Packing costs of outgoing orders	€ 6,496.50	€ 6,450.00	€ 4,515.00
Costs of errors	€ 1,741.50	€ 104.49	€ 120.62
Subtotal	€ 13,829.65	€ 16,205.94	€ 10.540.92
Transportation costs	€ 140,575.74	€ 139,716.63	€ 222,987.50
Total	€ 154,405.39	€ 155,922.57	€ 233,528.42

TABLE 24 COMPARISON BETWEEN 3 WAREHOUSES: EXPECTED TOTAL COSTS

7.2 Interpretation of the cost analysis

After calculating the costs that each alternative of TPL warehouses would consider, we focus on implementing these results into the company of Flying Fish eFoils. Over the past years, the Covid-19 pandemic had its influence on the world, and therefore the markets in which Flying Fish operates

potentially have shown different behaviour. Therefore, there are a lot of unknowns about the realistic market of their products, without the impacts of the pandemic. Therefore, three scenarios are drafted, in which the number of sales in the upcoming years varies.

Whenever the number of sales increases for the company of Flying Fish eFoils, they can start evaluating the satisfaction of their processes. If FFF has more liquidity available for the company to invest in their operations, their core business of distributing the e-foils improves. This implies that the company can invest their time in building a relationship with a TPL provider, so that the logistics at the company would be outsourced to people with expertise. Warehouse Y, the warehouse which is based in Germany is highly experienced in the sector of transportation and therefore takes away the effort on a significant part of the supply chain. Although the costs of Warehouse Y are significantly higher than in the current situation, the expertise of the warehouse helps optimising the warehousing management of Flying Fish. This would therefore be the ideal solution for the long term. Warehouse Z is less convenient in a situation in which the sales increase, as the warehouse has got the disadvantage of having a location that is not central within the map of sales of FFF. Therefore, if the sales would increase the holding and service costs of the company would not decrease in comparison to Warehouse X, but the transportation cost would increase significantly. Per order, the average distance to the customer would be considerably higher, which would cost the company a lot of money.

In the current state of sales, the company can afford switching their warehousing company. Although the transportation costs are slightly lower for Warehouse Y, the holding and service costs of this warehouse increases whenever this warehouse is selected. Therefore, the costs of selling an individual board would increase, which does not suit the promise of Flying Fish to distinguish themselves in the costs. In the current events, also warehouse Z would raise the costs of the sales significantly, which would not be ideal for Flying Fish. Therefore, in the current situation, other TPL warehouses are evaluated with the techniques from this study.

When the number of sales decreases over the upcoming years, it would be optimal for the company of Flying Fish eFoils to implement a TPL warehouse, such as Warehouse Z. While the holding and service costs would increase slightly, the company can then start primarily focussing on increasing their sales. The risks of the supply chain would be decreased an also their warehousing management is optimised with the help of TPL. This would build a strong base for whenever the sales increases as well. Although the transportation costs in Section 7.1.3 appear to be higher, this effect has less influence whenever the number of sales decreases. The lower error rate and the faster delivery time of the services increases the customer satisfaction and therefore increases the loyalty of their customers.

7.3 Implementation of the results

To implement the results, an implementation plan is written for the company of Flying Fish eFoils. In Section 7.3.1 we cover the objectives of this implementation, after which we directly cover the scope in Section 7.3.2. In Section 7.3.3 we elaborate on the deliverables of implementing TPL into the company, which we place on a timeline in Section 7.3.4. After this, we assess the risks of this implementation in Section 7.3.5.

7.3.1 List of objectives

During this implementation, the company has a list of objectives that they want to achieve with the decision of finding a TPL warehouse. The main objective of the company is to be able to focus on the other business activities, such as marketing, sales, and acquisition. This can be achieved by having a lower error rate of the supply chain operations, so that less attention has to be put into these activities, and by achieving a strategy-based inventory management to prevent negative developments to occur.

7.3.2 Scope statements

The scope of this implementation plan is created to clarify on which elements will be elaborated on during the implementation of the TPL company into the operations of Flying Fish. The implementation plan covers the objectives that are listed in Section 7.3.1. This implementation plan is based on the expectation that the company has found a TPL relationship with another company and that they have fully agreed to start cooperating with each other. Furthermore, this plan is based around the current processes and the current situation of the company of Flying Fish eFoils.

7.3.3 Outlines of expectations

Flying Fish has the right to expect certain improvements from the intertwining of both parties. Therefore, the deliverables from these operations are represented with the KPIs of the company. The following improvements are expected:

- Decrease of the average delivery time
- Increase of customer satisfaction
- Decrease of average inventory
- Decrease of carbon footprint

7.3.4 Task due dates

For the implementation of the results within the company, it is necessary to create a timeline on the transfer of the warehousing processes of Flying Fish eFoils. As shown in Figure 15, the company at a certain point has made an agreement and the start of the cooperation with a TPL provider, as this is the first milestone on this path. If all agreements have been made, Flying Fish must then stop replenishing the inventory at their current Warehouse X. The inventory at Warehouse X then starts to decrease, after which the next step is to start creating inventory at the TPL warehouse. The next big milestone is whenever the whole inventory at Warehouse X is emptied out, as of which the cooperation between the companies can shut down. After this the company can start fully integrating the warehousing techniques of the TPL warehouse, which can convey their expertise into the company of Flying Fish. The estimation for the time that this process takes is 6 months, after which the warehousing techniques of the TPL can be integrated.

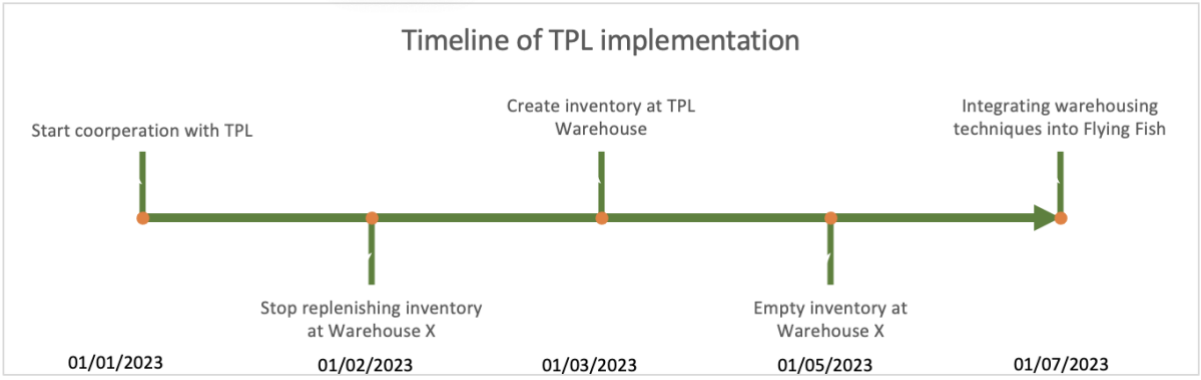

FIGURE 15 TIMELINE TPL IMPLEMENTATION

7.3.5 Risk assessments

To assess the risks that play a part in implementing a TPL relationship within the company of Flying Fish eFoils, a SWOT-analysis is done. Table 25 considers the strengths, the weaknesses, the opportunities, and the threats that are the effect of these operations.

	Positive	Negative
Internal	Strengths • Flying Fish can focus less on the process of their logistics and can now focus on and improve other business activities. • The operations of Flying Fish become more trustworthy and: By decreasing the percentage of error occurring, these operations are more reliable.	Weaknesses • The finances of Flying Fish eFoils are not clear. Having a lot of liabilities can possibly still have a negative influence on the future. • Flying Fish currently has low insights in their operations and their necessities for having a TPL relationship. This can have the effect of the deal between the parties being a misfit on the longer term.
External	Opportunities • TPL gives Flying Fish more insights into their data. Inventory levels and delivery times become clearer. • A better warehousing strategy can be adopted, as a TPL has expertise on inventory management and inventory forecasting.	Threats • Joining in a TPL relationship causes a partial loss of control of the assets within the company. The decisions on how the operation is done are outsourced. • Flying Fish loses a large share of the interaction they have with their inventory. The initial assessments of their goods are for instance more complex.

TABLE 25 SWOT-ANALYSIS

As visible in Table 25, the strengths and the opportunities mention the concepts of gaining more insights into the data of FFF, the operations becoming more trustworthy and expertise such as inventory management and inventory forecasting can be implemented into the processes of FFF. As mentioned in Section 1.2, the warehousing risks that are currently a threat to FFF are the lack of security procedures, liability for loss or delays and mostly in a lack of inventory. All these risks are beneficial to the processes of the company. However, implementing the strategy of TPL warehousing can thus be a solution to these risks.

7.4 Summary

To summarise, we have elaborated on the costs of the three alternatives of TPL. Each alternative was analysed on the holding costs, the service costs, and the transportation costs. Warehouse X has the lowest holding costs, while having a high cost of errors. Warehouse Y has significantly high holding costs, but their quality of operations is guaranteed by their low costs of errors. Warehouse Z distinguishes themselves in having low costs of processing incoming and outgoing orders. Warehouse Z is expected to be more than 3,000 euros less expensive than Warehouse Y, and approximately 5,600 euros less expensive than Warehouse Y. However, the transportation costs of Warehouse Z are more than 80,000 euros higher than the other options annually. When the sales increase with 50 percent, Warehouse Y would be optimal for Flying Fish due to their high level of expertise. In a situation in which the sales decrease, Warehouse Z would be the best option for Flying Fish. If the sales stay as in the current situation, research is done on other alternatives of TPL. An implementation plan was designed to guide the company among others with a timeline with the important milestones of the implementation. Moreover, this implementation plan included the objectives, the deliverables, and the risk assessments about the future expectations of the company.

8. Conclusion and Recommendations

Within this thesis, we conducted research for introducing TPL within the company of Flying Fish eFoils. A MCDM method for alternatives of TPL providers was created, after which several companies throughout the different countries in Europe were subjected to this decision-making. Two potential solutions were extracted from this method, after which a cost analysis was completed. The desired solution was then identified, and a scenario analysis was then performed to create clear insights in the implementation of this solution. In Section 8.1 we focus on answering the main research questions of this research. In Section 8.2, the scientific contribution will be elaborated on, after which we outline the points of discussion for this research in Section 8.3. Lastly, we focus on the recommendation for Flying Fish eFoils in Section 8.4.

8.1 Conclusion

As the current warehousing system of Flying Fish eFoils does not operate optimally, the company was interested in structuring a relationship with a TPL providing warehouse. Therefore, we constructed this research with the following main research question: *"How can a third-party logistics warehousing system be organised to decrease the warehousing costs of Flying Fish eFoils?"*

During this research, we constructed a theoretical framework on TPL warehousing, to create a MCDM tool which would consider the most important elements of the selection process of a TPL relationship. This tool helped summarizing the subjective opinion of a company on the processes and performances of a TPL warehouse. The tool is two sided, in which both the priorities of the choosing company are quantified, and the performances of the alternatives are quantified. The tool has weighted the six different dimensions: (1) Quality, (2) Costs, (3) Services, (4) Performances, (5) Information Systems, (6) Intangibles. Each of these dimensions were given a compensatory weight, which cumulatively equalled to one. The criterions of these dimension were then weighted by the different TPL warehousing alternatives on a Likert scale.

This tool resulted in two different alternatives, which had a high level of resemblances with the priorities of Flying Fish on how the warehousing function would ideally be structured. The two alternatives, which are referred to as Warehouse Y and Warehouse Z, have different value-added services and different costs of their services. After analysing the two different alternatives and comparing them to the current processes at Warehouse X, we can conclude that the optimal warehousing relationship depends on the expected number of sales of Flying Fish in the upcoming years. From our analysis, we expect that the sales increase, Warehouse Y would be optimal for Flying Fish due to their high level of expertise. Although the costs of the company are significantly higher than the current situation, the expertise of the warehouse can help optimising the warehousing management of Flying Fish. This would therefore be the ideal solution for the long term. In a situation in which the sales decrease, Warehouse Z would be the best option for Flying Fish. The lower error rate and the faster delivery time of the services would increase the customer satisfaction and would therefore increase the loyalty of their customers and would lower the risks of the supply chain of Flying Fish, hence they can invest their time in increasing the sales. If the sales stay as in the current situation, research is done on other alternatives of TPL. The techniques used in this research can function as a guideline for additional research.

8.2 Scientific contribution

The study that we have performed is based on the numbers and the interest of the company of FFF. Therefore, the scientific contribution to the literature is limited. As mentioned in Chapter 3, there currently is no literature on the application of multi-criteria decision-making processes to a case like FFF. Furthermore, there is no particular gap in the literature on the methods that are used during our research. However, due to the applied nature of this study, the aim of this research was to create a step-by-step MCDM tool that can be used in practice by other companies. The SMART formula was

applied to the business of FFF, for choosing the right alternative for their warehousing system. Future research can use this study and improve it to create a framework for companies in similar markets.

8.3 Discussion

The result of this research are highly subjective as the data that was collected was often the opinion of either the interviewer or the respondents. Due to the fact that the decision-making for TPL also includes a large part of the judgement of the choosing party, it is believed that these subjective elements should not be discarded from our research. This can similarly be explained due to the fact that this study is a case study about Flying Fish eFoils. The influence of these factors was reduced by setting up a MCDM framework that can be applied in multiple sectors of business, according to literature studies. This also had the effect that the companies which resulted as the best fit for Flying Fish eFoils were dissimilar from each other. The fact that the MCDM tool was filled in by the TPL companies themselves, decreased the validity of the answers, as a company often evaluates their processes at being a higher level than in reality.

Due to the fact that Flying Fish eFoils is still a start-up, the data that was processed in this research is sensitive for errors. The data that is currently being used from the software at the company contains a lot of errors and a lot of gaps when compared to the reality. Therefore, a lot of data was deleted or discarded to complete the calculations during this study. An example of this are the delivery times that are currently extracted from the data. During observations within the company, it was often the case that the delivery of a product was not registered at the right moment, which affects the lead time in our measurements. Additionally, the fact that that they have only existed for two years, carries the effect that they do not yet know where they want their future position to be. Therefore, the expectations can change over time, which means that the conclusion of this report can possibly not be in the direction that the company wants. Furthermore, as Flying Fish eFoils is in the growing stages of their business structure, this can increase the difficulty in interpreting the current sales. During our research, we have accounted a linear growth in every country that the company currently provides their product. However, this can have negative influences for the reliability of the conclusion, as for instance, this can affect the centre of gravity of the sales, or if company would expand their sales to new countries which are currently not considered in this research.

Another limitation for this research is the time frame in which it is concluded. In the given time frame, the research cannot be done as thoroughly as possible. This has a negative effect on the sample size of the research. The consequence is that the research does cover a smaller sample size than preferred within the research population. When this research would consider a different timeframe, the scope can have been broader which can have had its effects on the best solution of this research. For instance, other countries outside of Europe or the optimal solution between multiple options of warehousing can have been considered. Additionally, the companies can all be interviewed verbally instead of via the questionnaire, which would make those results more valid.

8.4 Recommendations

During the process of this thesis, recommendations were formed on the processes of the company. In Section 8.3.1 we go over the recommendations of the general processes, which were not necessarily in the scope of this research. Finally, in Section 8.3.2 we consider the recommendation of applying the theory of this thesis to the company.

8.4.1 General recommendations

A large limitation in our study is the gap between the reality and the data. The delivery times and the inventory level are currently not traced accurately, which causes mistakes to occur in retrieving information from the current data. A recommendation to solve this error, is to introduce a management system that suits the company and its core activities. In the observations, a lot of

activities are currently done directly from thought, exposes the company to potential errors occurring. A management system monitors all the statuses of the ongoings within the company.

Furthermore, it is recommended to create more time for building a strategy on the warehousing functions for the upcoming years. Currently the company is driven by the flow of the processes with little to no attention for the future of the company. When giving more notice to the future, opportunities are created to gather small patterns within the current events of sales. These little repetitions can create insights on for example the seasonal effects of the sales, and on where the company is going. These insights are used in building a strategy, to prevent sudden setbacks to occur. Spending more time on the strategy of the company can help reducing the costs. For instance, the demand and costs of the warehousing can be studied to create an Economic Order Quantity, which prevents backlog inventory or high numbers of stock levels.

It can be wise to wait for the disappearance of the effects from the Covid-19 pandemic. The pandemic can have affected the sales of the company, for instance due to the changes in the behaviour of the customers. This can lead to a misplaced view on future events of the company. It can be helpful to decrease the level of risks until those effects have disappeared, as the company is still in the growing stages.

The last recommendation is to lower the expectations of the targets of the company Flying Fish is trying to provide the best prices in the market, while additionally having the fastest delivery time, and above that even having the best quality of the products. As a company, being able to distinguish in fewer specification can improve that service even more, and often create more value to the customer.

8.4.2 Recommendations for applying this thesis

This thesis can be directly applied to the business of Flying Fish eFoils. However, when applying the theories of this project, there are a few improvements to consider. Firstly, due to the fact that the responses of the decision-making tool are recorded subjectively, the decision-makers, in this case Flying Fish eFoils, are included more in the process of these interviews. Their interpretation has got a large influence on the outcome of the tool, and in this thesis, this was not considered on that level.

Although the MCDM tool is used as a guideline to consider important aspects when choosing between multiple alternatives of TPL, the tool can be personalised more towards the perspective of the company, by including more criteria within the dimensions. For instance, as Flying Fish eFoils is selling an electrical product, they care a lot about the durability of their product and sustainability. Combining the personal priorities of the company with this MCDM tool, can increase the level of desirability of the outcome.

To create more accurate calculations on the costs of the alternatives, more detailed information should be used. The specific locations of where the customers are based can increase the level of preciseness when it comes to the transportation costs. Additionally, as the transportation costs are a part of distributing the product of Flying Fish, there measures of calculating future transportation costs should be improved. As the transportation costs shift frequently, for instance due to fluctuating gas prices, this process requires a lot of attention.

Reference list

Akhtar, D. M. I. (2016). Research design. *Research Design (February 1, 2016)*. doi:http://dx.doi.org/10.2139/ssrn.2862445

Altman, E. I., Iwanicz-Drozdowska, M., Laitinen, E. K., & Suvas, A. (2017). Financial Distress Prediction in an International Context: A Review and Empirical Analysis of Altman's Z-Score Model. *Journal of International Financial Management & Accounting, 28*(2), 131-171. doi:https://doi.org/10.1111/jifm.12053

Bask, A. H. (2001). Relationships among TPL providers and members of supply chains – a strategic perspective. *Journal of Business & Industrial Marketing, 16*(6), 470-486. doi:10.1108/EUM0000000006021

Brown, J. D. (2000). What issues affect Likert-scale questionnaire formats. *Shiken: JALT Testing & Evaluation SIG Newsletter, 4*(1).

Chapuis, B., Calmon, P., & Jenson, F. (2018). Advantages of Simulation. In *Best Practices for the Use of Simulation in POD Curves Estimation: Application to UT Weld Inspection* (pp. 9-10). Cham: Springer International Publishing.

Dolgui, A., & Proth, J.-M. (2013). Outsourcing: definitions and analysis. *International Journal of Production Research, 51*(23-24), 6769-6777.

Fishburn, P. (1967). Additive utilities with incomplete product set: Applications to priorities and. In: Assignments.

Heerkens, H., & Van Winden, A. (2021). *Solving managerial problems systematically*: Routledge.

Hsia, P., Samuel, J., Gao, J., Kung, D., Toyoshima, Y., & Chen, C. (1994). Formal approach to scenario analysis. *IEEE Software, 11*(2), 33-41.

Kaplan, R. S., & Norton, D. P. (1996). Using the balanced scorecard as a strategic management system. In: Harvard business review Boston.

Konidari, P., & Mavrakis, D. (2007). A multi-criteria evaluation method for climate change mitigation policy instruments. *Energy Policy, 35*(12), 6235-6257.

Kosow, H., & Gaßner, R. (2008). *Methods of future and scenario analysis: overview, assessment, and selection criteria* (Vol. 39): DEU.

Kučera, T., & Chocholáč, J. (2016). *Outsourcing as an innovative approach to logistics services of warehousing: a case study.* Paper presented at the The 10th International Days of Statistics and Economics: conference proceedings.

Large, R., & Kovács, Z. (2001). Acquiring Third-Party Logistics Services A survey of German and Hungarian Practices. *Supply Chain Forum: An International Journal, 2*(1), 44-51. doi:10.1080/16258312.2001.11517082

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of psychology, 22 140*, 55-55.

Liu, Y., Guo, H., Zhang, Z., Wang, L., Dai, Y., & Fan, Y. (2007). An Optimization Method Based on Scenario Analysis for Watershed Management Under Uncertainty. *Environmental Management, 39*(5), 678-690. doi:10.1007/s00267-006-0029-9

Løken, E. (2007). Use of multicriteria decision analysis methods for energy planning problems. *Renewable and sustainable energy reviews, 11*(7), 1584-1595.

Nemoto, T., & Beglar, D. (2014). *Likert-scale questionnaires.* Paper presented at the JALT 2013 conference proceedings.

Núñez-Carballosa, A., & Guitart-Tarrés, L. (2011). Third-party logistics providers in Spain. *Industrial management & data systems, 111*(8), 1156-1172. doi:10.1108/02635571111170749

Roopa, S., & Rani, M. (2012). Questionnaire designing for a survey. *Journal of Indian Orthodontic Society, 46*(4_suppl1), 273-277.

Seth, N., Deshmukh, S. G., & Vrat, P. (2006). A conceptual model for quality of service in the supply chain. *International Journal of Physical Distribution & Logistics Management, 36*(7), 547-575. doi:10.1108/09600030610684971

Sink, H. L., & Langley Jr, C. J. (1997). A managerial framework for the acquisition of third-party logistics services. *Journal of business logistics, 18*(2), 163.

Siregar, D., Arisandi, D., Usman, A., Irwan, D., & Rahim, R. (2017). Research of Simple Multi-Attribute Rating Technique for Decision Support. *Journal of Physics: Conference Series, 930*, 012015. doi:10.1088/1742-6596/930/1/012015

Tzeng, G.-H., & Huang, J.-J. (2011). *Multiple attribute decision making: methods and applications*: CRC press.

Unnu, K., & Pazour, J. A. (2019). *Analyzing varying cost structures of alternative warehouse strategies.* Paper presented at the IIE Annual Conference. Proceedings.

Utami, S. (2015). The influence of customers' trust on customer loyalty. *International journal of economics, commerce and management, 3*(7), 638-653.

Vaidya, O. S., & Kumar, S. (2006). Analytic hierarchy process: An overview of applications. *European Journal of operational research, 169*(1), 1-29. doi:https://doi.org/10.1016/j.ejor.2004.04.028

Vaxevanou, A., & Konstantopoulos, N. (2015). Basic Principles the Philosophy of Outsourcing. *Procedia - Social and Behavioral Sciences, 175*, 567-571. doi:https://doi.org/10.1016/j.sbspro.2015.01.1238

Velasquez, M., & Hester, P. T. (2013). An analysis of multi-criteria decision making methods. *International journal of operations research, 10*(2), 56-66.

Wilding, R., & Juriado, R. (2004). Customer perceptions on logistics outsourcing in the European consumer goods industry. *International Journal of Physical Distribution & Logistics Management, 34*(8), 628-644. doi:10.1108/09600030410557767

Appendix A1 Data for simulation

Country	Number of orders	Odds	Distance from the Netherlands	Distance from Germany	Distance from Spain	Preferred Shipment
Switzerland	0	0	628	510	1,193	Road
Sweden	20	0.082304527	1,210	1,119	2,678	Road
UAE	3	0.012345679	5,186	4,815	5,644	Air
United Kingdom	12	0.049382716	677	1,033	1,664	Road
Turkey	7	0.028806584	2,724	2,355	3,085	Road
Czech Republic	4	0.016460905	759	385	1,824	Road
Spain	14	0.057613169	1,472	1,617	0	Road
Slovakia	0	0	1,089	717	2,058	Road
Seychelles	1	0.004115226	7,884	7,537	7,826	Air
Romania	1	0.004115226	1,584	1,213	2,390	Road
Portugal	13	0.053497942	1,756	1,951	402	Road
Poland	11	0.04526749	947	607	2,160	Road
Ukraine	0	0	1,875	1,514	2,880	Road
Norway	3	0.012345679	948	1,042	2,382	Road
The Netherlands	57	0.234567901	0	372	1,472	Road
Mayottes	5	0.020576132	8,173	7,867	7,768	Air
Malta	1	0.004115226	1,938	1,722	1,653	Air
Lithuania	3	0.012345679	1,267	998	2,604	Road
Liechtenstein	1	0.004115226	632	449	1,299	Road
Latvia	2	0.008230453	1,348	1,118	2,735	Road
Italy	10	0.041152263	1,266	1,046	1,370	Road
Hungary	7	0.028806584	1,160	794	1,999	Road
Greece	8	0.032921811	1,931	1,610	2,180	Road
France	12	0.049382716	693	816	804	Road
Finland	8	0.032921811	1,636	1,512	3,098	Road
Germany	26	0.106995885	372	0	1,617	Road
Dominican Republic	0	0	7,389	7,750	6,699	Air
Denmark	1	0.004115226	535	570	2,007	Road
Cyprus	7	0.028806584	2,918	2,560	3,292	Air
Curacao	5	0.020576132	7,872	8,223	7,049	Air
China	0	0	7,486	7,224	8,788	Air
Bulgaria	1	0.004115226	1,834	1,472	2,430	Road
Belgium	0	0	190	426	1,288	Road

TABLE 26 DATA FOR SIMULATION

```
Sub Simulation()

Dim i As Integer
Dim j As Integer
Dim k As Double
Dim country As String
Dim dNet As Integer
Dim dGer As Integer
Dim dSpa As Integer
Dim pref As String


For i = 2 To 323                    'Loops through every order, assigns random value between 0 and
1 to k
   Sheets("Insert Data").Select
   k = Rnd()
   country = ""
   dNet = 0
   dGer = 0
   dSpa = 0
   pref = 0

   For j = 2 To 34                  'Loops through every option to see whether k is equal to
cumulative probability for country
      If k <= Cells(j, 4) Then
         If country = "" Then
            country = Cells(j, 1)
            dNet = Cells(j, 5)
            dGer = Cells(j, 6)
            dSpa = Cells(j, 7)
            pref = Cells(j, 8)
            End If
       End If
       Next j


   Sheets("Simulation").Select      'Insert the information to the sheet
   Cells(i, 1) = i - 1
   Cells(i, 2) = country
   Cells(i, 3) = dNet
   Cells(i, 4) = dGer
   Cells(i, 5) = dSpa
   Cells(i, 6) = pref
Next i

End Sub
```

Appendix A3 Part of simulation result of transportation costs

Order	**Country**	**Distance from the Netherlands**	**Distance from Germany**	**Distance from Spain**
1	Hungary	1,160	794	1,999
2	The Netherlands	0	372	1,472
3	Portugal	1,756	1,951	402
4	Sweden	1,210	1,119	2,678
5	Finland	1,636	1,512	3,098
6	Sweden	1,210	1,119	2,678
7	Germany	3,72	0	1,617
8	The Netherlands	0	372	1,472
9	Germany	372	0	1,617
10	Cyprus	2,918	2,560	3,292
11	The Netherlands	0	372	1,472
12	Sweden	1,210	1,119	2,678
13	The Netherlands	0	372	1,472
14	Malta	1,938	1,722	1,653
15	Portugal	1,756	1,951	402
16	Finland	1,636	1,512	3,098
17	The Netherlands	0	372	1,472
18	Germany	372	0	1,617
19	Hungary	1,160	794	1,999
20	Spain	1,472	1,617	0
21	United Kingdom	677	1,033	1,664
22	Italy	1,266	1,046	1,370
23	The Netherlands	0	372	1,472
24	United Kingdom	677	1,033	1,664
25	Portugal	1,756	1,951	402

TABLE 27 PART OF SIMULATION RESULT

Appendix A4 Simulation results

Simulation		Warehouse X	Warehouse Y	Warehouse Z
1	Total distance	411,780	420,199	635,293
	Total distance road	236,053	249,124	463,555
	Total distance air	175,727	170,995	171,738
2	Total distance	478,608	479,332	709,556
	Total distance road	241,913	249,128	480,210
	Total distance air	236,695	230,204	229,346
3	Total distance	437,044	430,158	651,385
	Total distance road	267,703	266,085	486,498
	Total distance air	169,341	164,073	164,887
4	Total distance	437,877	430,416	644,946
	Total distance road	259,794	256,546	472,502
	Total distance air	178,083	173,870	172,444
5	Total distance	403,521	399,569	635,335
	Total distance road	254,218	256,539	486,905
	Total distance air	149,303	143,030	148,430
6	Total distance	430,481	425,548	645,793
	Total distance road	259,436	261,461	477,073
	Total distance air	171,045	164,087	168,720
7	Total distance	441,612	429,516	679,974
	Total distance road	227,382	224,500	464,889
	Total distance air	214,230	205,016	215,085
8	Total distance	366,448	361,631	616,235
	Total distance road	264,176	262,158	515,470
	Total distance air	102,272	99,473	100,765
9	Total distance	439,040	437,424	675,092
	Total distance road	231,777	237,833	470,118
	Total distance air	207,263	199,591	204,974
10	Total distance	401,833	398,839	638,137
	Total distance road	239,929	244,143	478,047
	Total distance air	161,904	154,696	160,090

TABLE 28 SIMULATION RESULTS