Master Thesis in Management of Technology

Design of a Decision-Making Business Process for Transport Method Selection of Shell Chemicals

A Process Balancing Decarbonization, Cost and On-time Delivery Key Performance Indicators in Transporting Chemicals to the European Customers

September 2022

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TU Delft

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Preface

This master thesis is the finalization of my master's degree program in Management of Technology at Delft university of technology. This thesis project is conducted in collaboration between the Technology, Policy and Management faculty of TU Delft and Shell Chemicals HSSE & Logistics department of Shell office in Rotterdam between February 2022 and August 2022. I would like to express my sincere gratitude to my first supervisor Marcel Ludema, for his patient support, my second supervisor Pieter Bots, and the chairperson Lorant Tavasszy for their brilliant comments and suggestions during the project. Special thanks to my first, second External supervisors and mentor at Shell, who coached me continuously during the project and helped me set the direction and their help in making this work possible, despite the difficulties faced in between. I would like to give my warm thank to other people in the company for their valuable collaboration in making this project.

I am very grateful to my family members for their support during the project. They were providing me with beneficial inspiration during the accomplishment of this project. I also thank my close friend for his motivational energy to me and all my other friends who were understanding me and for their fruitful advice for passing some difficult days with a high workload in this project.

Fatemeh Shirvani
Delft, September 2022

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Summary

Shell is a well-known global company with branches in more than 70 countries worldwide that function in the energy and petrochemical products industry. This project is accomplished at the request of the Shell land logistics team as part of the chemicals and products (C&P) HSSE[1] & logistics department in Rotterdam, Netherland, for chemical transportation to European customers. This project is the first step of the land logistics team for addressing sustainable delivery and it is part of the department alignment plan with the company's target of making 50% of the supplied fuels for road transport, carbon neutral by 2030. Accordingly, the land logistics team of the C&P department has set a goal of logistics emission reduction of 50% by 2025. In this project, sustainability is considered the dominant key performance indicator (KPI) that affects different logistics features and the land logistics team is aiming at considering the cost and on-time delivery (OTD) as affected KPIs and executing the project in September 2022. Since there is not a clear instruction on how the transport method for delivering chemicals to the customers must be selected while balancing the three KPIs of sustainability, cost and OTD, this thesis project aims to provide a decision-making business process with balanced KPIs to assist the land logistics team for selection of the most appropriate transport methods for the lanes. Therefore, the design methodology is pursued to accomplish this thesis project with the following main activity:

"Design a decision-making business process balancing KPIs of sustainability, cost and OTD for transport method selection of Shell chemicals"

To state the main thesis activity, the business process design methodology (BPDM) is utilized which is generated in this project from combination of guidelines of Dym & Little and stage gate methods. Based on this, the project sub-activity and questions are derived. The background study review verifies the necessity of conducting this project since there exists a design gap. It entails that in the previous studies there is not a clear guidance on how the transport methods can be selected for each lane while balancing KPIs. Furthermore, there is a judicial mandate for conducting this project.

There is not a documented file at Shell for the current decision-making system and it is generated in this thesis project. Currently, there is no procedure for selecting the transport method in the decision-making system but the selection of the haulier leads to assigning the transport method to a lane. A lane entails a specific product loaded from a specific loading site by a specific haulier that utilises a specific transport method toward a specific customer in a specific country and city. After technical approval of a haulier by Shell, the hauliers that are able to deliver to the customer location are asks for payload[2], lead time[3], and price. For the acceptable lead time and payload, the cheapest haulier is selected, blocked in the lane and the hauliers' transport method is assigned for that lane. The drawbacks of this system are that the transport methods and the CO_2 emission of their transport are not asked as a determining factor for selection of the hauliers. Moreover, this system does not allow for achieving the team target of 50% CO_2 reduction in logistics. The design assists in selecting between different transport methods for a lane and the hauliers will be asked to deliver by the most appropriate transport methods as the result of the design. For that, the outbound logistics portfolio is analyzed and a set of lanes as the representative of other lanes are selected to be involved in this project. The requirement for the design is defined as the hauliers' input for available sustainable logistics options they can provide to their pre-determined representative lanes. Also, the effect of the options on CO_2 reduction, increase of the logistics price, probable affected OTD, the

[1] Health, Safety, Security, Environment
[2] Maximum product load that can be transported
[3] The time between charging at the loading site and discharging of the product at the customer location

certainty of the option, and the time framework for the execution of the option are asked via specific questionnaire from each haulier for representative lanes. The analysis of the responses shows that the fuel change option reduces the CO_2 significantly and makes the logistics price slightly more expensive. The payload increase option decreases the emission very slightly and the intermodal option impacts the price remarkably, reduces the CO_2 significantly, and affects the OTD negatively. This analysis shows in total 40% logistics CO_2 reduction and 45.36% of logistics cost increase. Since chemical products are valuable products the share of the logistics price from total by which the customers are charged, is maximum 6% that leads to 2.72% total price increase.

For making the design, mind mapping is utilized because of high level of complexity of the factors that can determine the applicability of an option for a lane. For that, the entire responses from the hauliers are communicated to the senior sales managers. It emerged that the options have different requirements, consequences, certainty, and execution time frameworks named as the “main factors”. In addition, it is found that other “additional factors” affect the applicability of an option as well such as the customer portfolio in sustainability, prices provided by competitors in the market, and the existence of sustainable products besides sustainable transport. The business process balancing those factors is designed and visualized by which the selection of the transport method occurs by following this business process. Then, the design is validated by applying it on the representative lanes and discuss it in direct discussion with the responsible sales manager for each customer to assure which main and additional factors apply for each lane. Then responses are compared with the hauliers responses. Among 14 lanes, 7 lanes with currently direct road transport method are possible to become sustainable by the design in September 2022 with fuel change, payload increasing, and renewing truck options. Considering these options and their effect, the design results on average in 13.6% total CO_2 emission reduction, 6% logistics price increase. With considering maximum of 6% for the share of logistics from total price, maximum 0.36% total price increase is the result which is insignificant number. The rest of the options as electric trucks and intermodal are uncertain and not applicable for implementation in September 2022.

A large number of stakeholders are identified in this project and they are classified into internal and external, primary and secondary as well as the critical stakeholders that can hinder the project execution. For further development of this project, the primary internal and critical stakeholders namely the supply planners, marketing, financial, and sales managers teams are considered to be in close and direct contact with the land logistics team. For implementing this project it is suggested that a set of sessions must be developed in presence of aforementioned stakeholders for emphasizing the importance of sustainable delivery because of the lack of alignment between them about this notion, the findings of this project can be elaborated and a blueprint has to be generated for developing their roles in project execution. Also, generating certificate can guarantee the customer for sustainable delivery. A side agreement with the hauliers and invoices for the customers are essential for implementing this project and execute the mandate for transporting sustainably.

Finally, Shell benefits from this project by expanding the lanes spectrum to reach its goal for 50% emission reduction by 2025, it can claim in aligning with the mission statement of the company as well as the reduction of part of scope 3 of the emissions. Also, Shell can make money out of this project by following measurements:

- Maximising 1% total price increase by which the customer is charged
- Making agreement with the hauliers for utilising Shell HVO and Bio-LNG fuels for their trucks to obtain fuel tickets and trade them

From this project it can be concluded that the three main KPIs are not the only important KPIs and there are much more factors that affect the applicability of a sustainability option for a lane that are

shown in the design. The first limitation of this project is the small representative size of the lanes. This is because another limitation of extreme dependency on the hauliers for their answers to the questionnaires. A larger number of lanes in questionnaires could result in no input from them. The other limitations were the time constraints, prolonged connection with hauliers for obtaining required information, and different perspectives between different teams in the C&P department about the sustainable logistics that made some restrictions on the project. It is recommended to consider other KPIs such as risk and safety in the design for further projects and new hauliers can be taken into account to be involved in the decision. Furthermore, applying design on the lanes showed that only lanes with current direct road transport method can become sustainable and improve sustainability for the lanes that are already sustainable with intermodal transport is difficult and timekeeping. It can be recommended to consider only lanes with currently direct road transport for further projects, development and execution of this thesis project. Moreover, a large number of stakeholders are identified for this project and an in-depth investigation of the stakeholders can be considered a unique topic to be probed profoundly in further projects. Furthermore, this project involved four types of products and for thesis execution and further projects, the focus can be narrowed down to just one product group, such as PODer, to involve more lanes as representative lanes for investigation in the next projects as well as the involvement of real customer in the project development.

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Contents

List of Abbreviations

OTD	=	On-time delivery
C&P	=	Chemicals and Products
HSSE	=	Health, safety, security, and environment
LSPs	=	Logistic service providers
KPI	=	Key performance indicator
BPDM	=	Business process design methodology
MCDM	=	Multi-Criteria Decision Making
LNG	=	Liquified Natural Gas
HVO	=	Hydrotreated Vegetable Oil
GTL	=	Gas To Liquid
GHG	=	Green House gas
3PL	=	Third party logistics
4PL	=	Fourth party logistics
TTW	=	Tank-to-wheel emission
WTT	=	Wheel-to-tank emission
WTW	=	Well to wheel emission
UML	=	Unified Modelling Language
ERP	=	Enterprise resource planning
IDT	=	Information and Digital Technology
E&S	=	Economic & Scheduling
TBI	=	Transport & Business Information

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1 Introduction

In this chapter, the motivation and justification for conducting this thesis project are provided as an introduction to the project. A general overview of the project's importance for the decisions in transport selection by adding sustainability to the system is presented. Since this thesis project is conducted as an internship at Shell company, in this chapter a brief introduction to the Shell and C&P HSSE & Logistics department is provided. Then a description of the Shell land logistics team incentive for considering sustainability and affected the cost and OTD KPIs in the transport is provided and it is followed by a vivid problem statement as part of the problem definition stage from the design. At the end of this chapter, the report outline presents instructions for reading the thesis report.

1.1 decisions for transport method and environmental impacts

The current manner of transport organizing will grind to a halt at some point because unimpeded and optimal transport will be fundamental to logistics organizing in the not too distant future (Hutchison Ports ECT Rotterdam, 2011). Increasing global trade and the importance of reliability in addition to concerns about climate change and CO_2 reduction imply the necessity of an optimized logistics selection (Hutchison Ports ECT Rotterdam, 2011).

As stated by Wu and Dunn (1995) and Kelle et al (2019) the transport method selection is a concrete decision that impacts effects on the environment. However, environmental impact is considered not so important and the conventional KPIs involving technical requirements, cost, delivery quality such as safety, and on-time delivery are mainly considered for decisions in product transport (Sarabi & Darestani, 2021). Making decisions between different transport options by considering sustainability criteria is challenging and complex since the consolidation of the transport is the most important item that logistical companies are concerned about. Sustainability can affect the consolidation significantly and in some cases requires governmental and industrial close cooperation (Aronsson & Huge Brodin, 2006). The companies at the micro level are not the only party that can improve the sustainability in transportation and governmental measurements at the macro level are enablers of infrastructure preparation for addressing sustainability (Kumar & Anbanandam, 2020). At the end of chapter 8, these measurements are combined with this project result to mention the required measurements at the macro and micro levels for fostering sustainable transport.

1.1.1 Importance of environmental sustainability and OTD reliability of the logistics

Sustainability aims are becoming more important gradually because of the impact on the earth and potential damage to the atmosphere. The emission from logistics activities in Europe has to be reduced by an average of 15% by 2025 and 30% by 2030 as a target of the European Commission (European Commission transport emission, 2019). This aim has to be adopted by all involved countries named as "low emission mobility target". Accordingly, the Netherlands is committed to the Paris agreement for the prevention of global warming caused by GHGs[4] and to reduce them to zero by 2050 (Dutch Government, 2017). It encompasses all activity sectors in the industry. Logistics makes up 25% of total GHG emissions in Europe (European Commission transport emission, 2019; IPPC, 2018). However, it is important to be taken into consideration, since

- According to the sustainability agenda of the European Commission the total GHG emission has to be reduced by more than 55% below the level of the year 1990 for all industry sectors by 2030 (European Commission climate action, 2020). According to the report from the EU commission, the transport GHG emission has started to reduce from 2007 but compared to

[4] Greenhouse Gases

the other sectors this decline is very gradually and substantial steps need to be taken for a steep slope in the graph to achieve the goal of 2050 for total emission neutrality (European Commission transport emission, 2019). The last report up to 2014 shows this trend in the graph in figure 1.1.

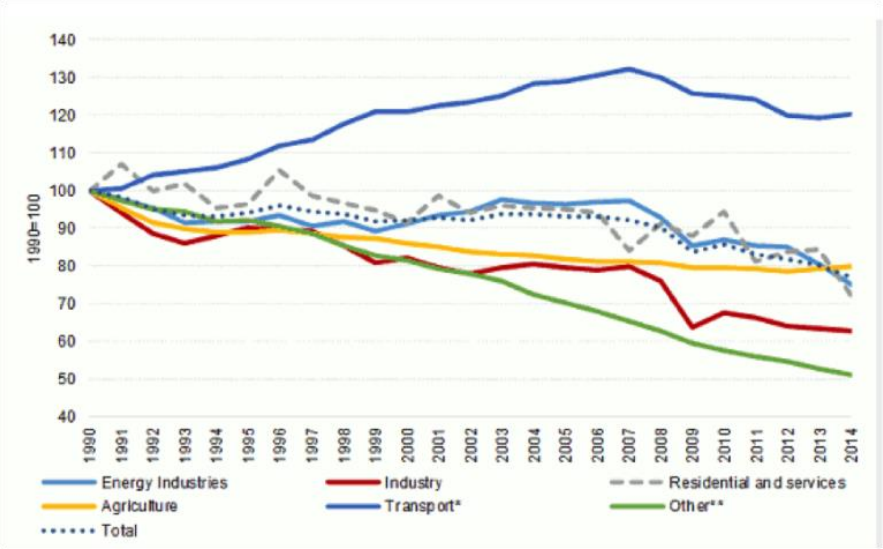


Figure 1.1: GHG emission reduction trend from 1990 level in different sectors (European Commission transport emission, 2019)

According to this graph, it is obvious that the logistics sector is still lagging in emitting lower amounts of GHGs compared to other sectors' efforts. Since the majority of the transport occurs by road, the EU commission expresses that road transport accounts for 73.4% of the total emission compared to the other modes (European Commission transport emission, 2019). Although direct road transport shows a better performance for OTD as an important consolidation factor, the focus has to be given to this transport method to make it sustainable because of its great share in the transport and impact on the emission (Aronsson & Huge Brodin, 2006).

When it comes to making freight logistics sustainable, the price and OTD are the most important factors that the customers concern about (Wan Liu, 2016). Both of these items have to be considered by the suppliers to stay customer-centric and reliable. Also, to stay competitive in the market these consolidation factors have to be under attention in case of any demand for changes in the logistics. Sustainability has become an important KPI among all industries and it affects logistics costs and OTD of the product transportation to the customer. Therefore, considering sustainability makes the consideration of the logistics costs and OTD important.

1.2 Introduction to Shell company and C&P[5] HSSE & logistics department

Shell is a worldwide spread company performing in the energy and petrochemical products in more than 70 countries. This company explores, produces, refines, and markets oil, gas, and chemical derivatives from them in both parts of energy and non-energy products (Shell, 2021). Shell involves four sections of integrated gas and new energy, upstream, downstream, and projects and technology. As part of downstream, the Land logistics team of chemicals is handled in C&P HSSE & logistics department. This project has been conducted at the request of this team.

1.2.1 Shell company mission statement and this project

[5] Chemicals and products

The mission of the Shell company influences all of the activities in all of the departments to stay competitive and share value with the stakeholders (Shell, 2021). This project is aligned with the second mission statement of Shell company as follows:

1. Operational excellence constantly achievements
2. Safe, environmentally sustainable, and economically optimum business conduction
3. Innovative, result-oriented, diversified and inclusive team members collection

1.3 Importance of the environmentally friendly transport for the Shell chemicals logistics

The freight transport of Shell in the European region is requiring a complex network of individual supply lanes[6], making use of all modes of transport: Vessels, barges, trains, trucks, and a combination of them. Shell C&P land logistics team needs to prepare a plan for the near future and step in the sustainable delivery journey before being forced for taking any action by the European Commission (European Commission, 2001). Nevertheless, there is not a clear instruction for the team on how to select the most appropriate transport method for a lane which has balanced the sustainability (CO_2 emission reduction), cost and OTD KPIs. Mainly road direct transport and intermodal[7] transport are utilized for transporting the chemicals to European customers which are impacted by a congested and overstretched logistical market. This matter results are decreasing performance of supply reliability[8] and increasing costs for Shell chemicals department and therefore a negative impact on some specific customers (Interviewee P2, personal discussion, March 10, 2022). Therefore, on-time delivery of the product is an important KPI that impacts the customer vision into Shell chemicals department performance. To reduce the share of the road emissions, make it environmentally sustainable and align with the EU commission's aim for improvement of lower emissions measurements in logistics, the land logistics team of HSSE & logistics is aiming to reduce the logistics emission to 50% by 2025 that is related to scope 3[9] of the emissions (Interviewee P2, personal discussion, July 18, 2022). Although some improvements for the reduction of scope 1 [10]and 2[11] emissions have already commenced, a small part of scope 3[12] relative to chemicals delivery is still lagging (Shell climate target, 2022). This project is considered an important project for the land logistics team since this team considers this thesis project execution in September 2022 (Interviewee P2, personal discussion, July 18, 2022).

Reliability in terms of being on time is the other momentous KPI that impacts the customer vision into Shell's accountability and consequently Shell's market share value (Choon Tan et al., 2002). In case of not serving OTD, customer loss ensues, the market share price for Shell would reduce and it can be considered as a defeature for Shell while making an opportunity for the competitors to take over and become the suppliers of chemical products to Shell customers. Different sustainability options that can be applicable to be used in this project might affect OTD. In case of failure in addressing OTD correctly all of the customers in the chain will be affected negatively since their scheduling will be negatively influenced by the delays (Davis, 1993).

1.3.1 Necessity of improving the decisions for Shell by adding sustainability

Sustainability is not comprised in the current decisions for assigning transport methods to the lanes. Considering sustainability as the dominant factor in this project impacts the logistics cost and OTD and the decision for selecting for transport method must be optimized based on these three factors.

[6] A lane involves the loading site, product, haulier, destination location, and customer name
[7] Intermodal: Combination of road-rail-road or road-barge-road
[8] Measurable by survey results from surveys filled by the customers each 6 months
[9] Indirect emission from the use of products being sold to the customers
[10] Scope 1 emission: Direct Emission from All Shell Operations(Royal Dutch Shell plc, 2021).
[11] Scope 2 emission: The energy used for running the operations
[12] Scope 3: Emission from the energy and chemical products of Shell that Shell produces(share of the chemical products is very small compared to energy products)

- According to the historical data of Shell, it is a front runner in new technology or any sustainability aim, from products to the production process. Emission of chemicals logistics is one part of total emission containing all three scopes of the emissions that have to be considered to achieve the goal of emission neutrality by 2050 (Shell climate target, 2022). These three scopes are depicted below in figure 1.2.

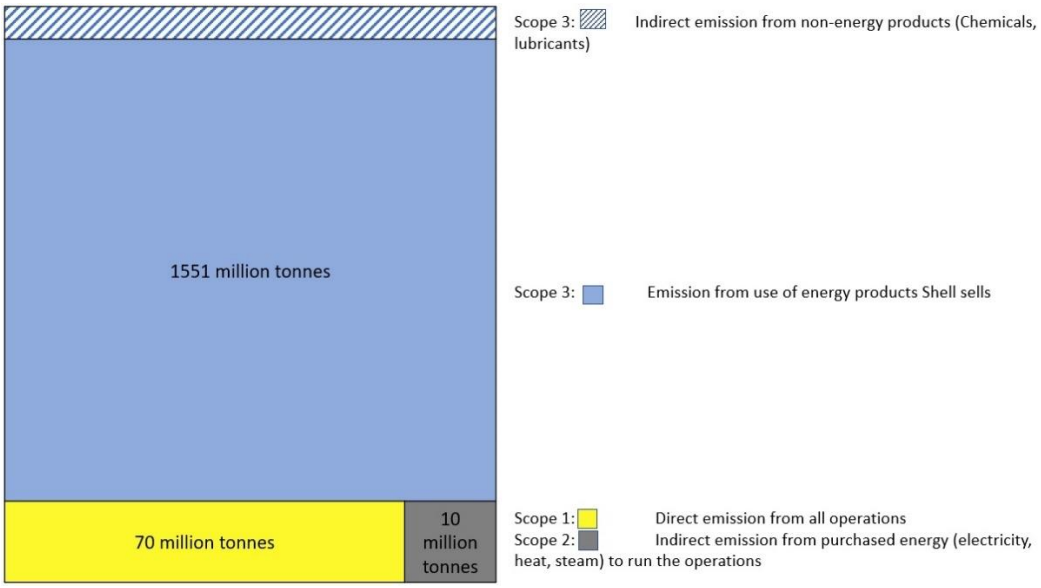


Figure 1.2: Scope 1,2&3 emissions of Shell based on the 2019 report
(Royal Dutch Shell plc, 2021)

According to this figure, the emission in this project is associated with a part of scope 3 of the emissions from chemical products logistics. This is shown in the dashed section. It can be seen that a small portion of the total emission is related to chemical products in scope 3 (Royal Dutch Shell plc, 2021). This dashed scope involves total emissions from the chemical products, processes, and logistics. The share of the logistics from total emission in chemicals is low and considering all scopes, logistics emission of chemicals allocates a very tiny portion to itself. However, aligning with the mission statement affecting all departments makes the CO_2 reduction in all activities of the C&P department important.

- The sustainable products that are already made need to be delivered sustainably and it is not wise to deliver them in a not environmentally friendly manner. Also, according to the database of Shell, the majority of the delivery methods is by direct road and in some cases combination of road-rail-road and road-barge-road as intermodal transport (Interviewee P1, March 15, 2022). Therefore, making road transportation sustainable becomes important besides the measurements for intermodal transport for making them more sustainable.

Recently concerns about the environment and climate change have increased. Therefore, companies in all industries have to restrict or remove the CO_2 footprint in their logistics process as one of the core activities in the firm operations to cut back their role in global warming (McKinnon, 2010). Shell company is not an exemption and as an international and widespread corporate in the energy and industry sector, it has a remarkable impact on the environment and it has to prevent climate change by controlling and reducing the carbon footprints from its operations (Paris Agreement, 2021). Therefore, addressing sustainability goals is essential for Shell's C&P department as a section of Shell company.

1.4 Problem statement

The motivation for conducting this project is profoundly expressed previously in this chapter. However, in this section the problem felt by the land logistics team is defined vividly. The land logistics team aims to add sustainability to the current system of product delivery to European customers. With the awareness of the fact that sustainability KPI affects the logistics cost and probably OTD, and there might be more than one transport method available to be applied on a lane, there is no clear instruction for the team on how decisions should be made to select the most appropriate transport method from the available sustainable logistics options. In other words, there is no information for the land logistics team about what to consider to come up with the applicable transport option for the lanes. This instruction is the design of the business process that is generated in this project for the land logistics team.

1.5 Tank to wheel (TTW) emissions involvement in this project

The emissions that the land logistics team considers to reduce with the result of this project is direct emission from transportation. So, the (Tank-to-Wheel) TTW emissions are involved. This type of emission points out the instant emission from the use of the fuel in the transport mode and the emissions during driving (Curnow & Brake, 2019). This is not the holistic view of the emission since the area of decarbonization and environmentally friendly transport covers the entire emission of the fuel in the production and its supply namely (Wheel-to-tank) WTT and usage which is called TTW to make up Well-to-Wheel (WTW) emissions (Otten, 2021; Heinold, 2020). The limitation of this project for collecting WTT information for different energies used in the transport and by the request of the land logistics team for considering only direct emissions, just TTW emission is included in this project.

1.6 Thesis project outline

This thesis project encompasses 9 chapters. In the current chapter, the problem is defined and the motivation and importance for accomplishing this thesis project first in a broader view and then for Shell are presented. In chapter 2, the methodology and project sub-activities and questions as well as the setting for the background study are presented. In chapter 3 the background study setting is executed and a set of literature is reviewed to come up with the design gap defined as no existence of instruction for Shell to capture and generate a decision-making business process. Then the current process of assigning a transport method to a lane is provided and the outbound logistics for transporting chemicals to European customers is analyzed in chapter 4. In chapter 5, the requirement for the design defined as the hauliers' input for available sustainable logistics options and effect on KPIs are carried out and a profound analysis of the responses is presented in that chapter. In chapter 6, the design of the decision-making business process is provided and the contribution of the design to the current system is visualized. In chapter 7, the design is validated by making the validation questionnaires and filling them out in direct discussion with relevant sales managers. In these questionnaires, the design is applied to the lanes and the lanes that sustainability option works for them are the result of this application and presented in chapter 7. In chapter 8, the general analysis of the project such as the stakeholder analysis, the growth strategy for this project, and SWOT analysis are conducted and a proposal plan for implementing this project involving the primary internal stakeholders is provided. In chapter 9 the conclusion from this project, reflection, limitations and recommendations for further studies are presented.

2 Thesis Project Methodology

In the previous chapter, the incentive for accomplishing this project is presented from a general perspective and specifically from Shell's perspective as well as the vivid definition of the problem statement. In this chapter, the methodology for conducting this project is provided as well as the aim of the thesis project, deliverable, and the project approach. The utilized methodology for conducting the project approach is introduced and the steps in this methodology are described in depth in this chapter. Moreover, the main project activity and the project sub-activities and questions are provided. The framework of this thesis project is mapped to present the project phases and how the project sub-activities and questions are fulfilled in different chapters. This framework is presented at the end of this chapter and a sub-conclusion at the end of this chapter reviews the most important components provided in the chapter.

2.1 Objective of this thesis project

The main thesis project objective is to design a decision-making business process for the land logistics team of the C&P HSSE and logistics department in Rotterdam to incentive an optimized decision for selection between different transport methods for each customer considering desired KPIs. In other words, it is a business process for assisting the land logistics team decide better in this multi-criteria decision making (MCDM) for each lane between available regular and sustainable transport methods to serve sustainability, affordable cost, and OTD and assist the land logistics team to deliver its climate target. So, the main targets in this project are as follows:

- Monitoring the available sustainable logistics options for each lane
- Providing the decision-making business process as an instruction to show how the decisions for selecting the most appropriate transport method should occur.

2.1.1 Project deliverable

The deliverable of this project is a business process in form of text and a map in which all of the factors that must be considered for selecting the most appropriate transport method are mentioned. Furthermore, the design is applied to a set of lanes for the validation of the business process, and the most appropriate transport method for each lane is selected. This validation is provided in form of text for the lanes in each product group and the result is provided in a table in chapter 7. Table 7.2 shows the end result of applying the design on the lanes that shows which lanes, by mean of which sustainability options can become sustainable immediately in September 2022.

2.2 Project Approach

The thesis project approach is a design approach since the incentive is to provide a decision-making business process to optimize the decisions for transport method selection. For conducting this project, at the first step desk research was accomplished to collect secondary data from Shell records and documents and also scientific articles to obtain insights about the multi-criteria decision-making system. The aim is to receive insight into the design of the business process and its requirements. Also, primary data is collected from the haulier for available sustainable transport method options for each lane and the effect of the options on CO_2, logistics cost and OTD, and the senior sales managers' input for the hauliers' responses for making the design. The required data for this design are both types of qualitative and quantitative. Qualitative in terms of in-word data about the current process of assigning a transport method to a lane and other managerial input and quantitative in terms of the numerical data such as cost, CO_2 emissions, etc. In addition, since this project is conducted for the first time in this department some not documented data need to be collected for

the first time as primary data from different teams in Shell C&P department and haulier to make the design.

2.2.1 BPDM design methodology

Since the project approach is the design a compatible methodology is associated with this approach. Several methods can be considered as a base and adjusted according to the thesis project requirements. The double diamond method of the design introduced by the design council in the UK does not comply perfectly with this project design and its requirement for the analysis of the current decisions since this is a vulnerable method and restructuring this method to comply with this project makes it unreliable (Gustafsson, 2019). The Dym & Little designing method is the most appropriate method to be used as a guideline in this thesis (Dym & Little, 2009). This method provides specific design strategies for each stage at a high level, with overall views of the design process (Wynn & Clarkson, 2018). This guideline is selected since this is a familiar method from the previous courses and it is flexible to be adjusted to this project goal and requirements. This method is considered a guiding tool for the design, and it is adjusted according to specific requirements in this project relative to the project objective, data collection, and validation. Also, the stage gate model is combined with the guidelines of the Dym & Little method to take the most from the design since it is considered a value-creating business process. According to the design methodology named BPDM, different stages of the project are followed iteratively. After each stage, there is a gate by which the previous stage is monitored, additional required criteria may be added and any change can be applied to the previous stage to obtain considered deliverables required for the input of the next stage (Cooper, 1990). So, the quality of input and output data for each stage is improved. In this thesis project, the performance of the gates is conducted in presence of Shell supervisors and mentor as the gatekeepers.

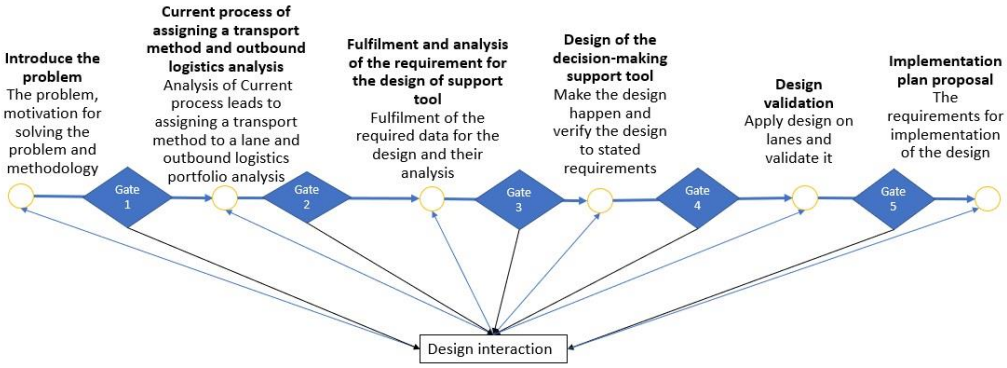


Figure 2.1: BPDM design methodology
(own figure)

- Introduce the problem: In this stage, the problem is elaborated and the motivation for solving the problem is provided. This criterion is provided in chapter 1. Also, the approach for tackling the problem and methodology are investigated in this chapter. The setting for reviewing background studies to address the design gap and essentiality of conducting this project is presented in this chapter and executed in the next chapter.
- Current process of assigning transport methods and outbound logistics analysis: In this stage, the current process by which the transport methods are assigned to the lanes is analyzed in a generic decision-making system and decision-making tree. Also, the outbound logistics portfolio for a set of lanes is analyzed in which the specifications of the lanes involving the loading site, customer name and location, the product, the haulier, and the current transport method are described. In chapter 4 this analysis is provided.
- Fulfilment and analysis of the requirement for the design of the business process: The design of the decision-making business process requires important information from hauliers about

available sustainable logistics options for a lane and affected KPIs. This information is captured from the hauliers and profoundly analyzed.

- Design of the decision-making business process: In this stage for the options provided by the hauliers, communication with senior sales managers occurred and the design is provided in form of text and visualized in a process. It is followed by the verification table in which the requirements of the design are checked.
- Design validation: To validate the design it is applied to the lanes and the result of the validation for the lanes is provided in form of a spreadsheet and narrowed down in a table in chapter 7.
- Implementation plan proposal: The suggestions for the further development and execution of this design for the lanes assessed in the validation are proposed to the Shell land logistics team. These suggestions are essential for the involvement of primary stakeholders in the execution of the design.

2.2.2 Project main activity and project activities and sub-questions

According to the objectives of this thesis projected stated before, the following main project activity is pursued:

"Design of a decision-making business process balancing sustainability, cost and OTD KPIs for transport method selection of Shell chemicals"

To satisfy the main project activity the following sub-activity and questions are formulated that align with the design methodology:

- **Project sub-activity 1**: "Analyse the current process of assigning transport methods to the lanes and outbound logistics portfolio."

This project activity is addressed in chapter 4. By investigating the current process of this assigning the deficiencies of the system are clear and the place where the design affects the system is shown. Also, the outbound logistics is analyzed to obtain the features of the lanes such as the loading sites, haulier, customer, etc.

- **Project sub-activity 2**: "Fulfil the requirement for the design of the decision-making business process."

In this project activity, the requirement for the design is fulfilled. This project activity encompasses two questions.

➢ **Project question 2.1**: "What are the possible sustainable transport options?"

This question is an important question by which the available sustainable options for the lanes are presented.

➢ **Project question 2.2**: "How the KPIs are affected by the options?"

In this project, the CO_2 emission reduction, price, and affected OTD are considered the KPIs and it is important to obtain the influence of the options on these KPIs.

- **Project sub-activity 3**: "Design the decision-making business process."

In this project activity, the design for different options' applicability is generated and verified. The main and additional factors of the different options are considered to be considerations of design.

- **Project sub-activity 4**: "Validate the design."

In this project activity, the requirements for design validation are identified and generated design in the previous activity is validated by applying the design to the lanes and investigating the applicability of the sustainability option.

- **Project sub-activity 5:** "Analyse the project generally."

In this project activity, a broader scheme of this project and the effect of the design are considered. In fact, this project is considered in a broader spectrum to map the stakeholders, find out project strengths, weaknesses, the growth strategy for this design, and its effect on the customer contracts.

- **Project sub-activity 6**: "Propose implementation plan for the design execution."

In this project activity, the suggestion for executing the design on validated lanes is presented. The involvement of the primary stakeholders and their role in the further development of this project are addressed in this project activity.

2.3 The setting of background study reviewing

To emphasize the importance of KPIs for this thesis project and to come up with the design gap a set of the literature is reviewed. In this section, the structure of how this review is organized is presented and in the next chapter this setting is executed and relevant kinds of literature are reviewed. The literature review encompasses two main sections as follows and for both sections, the review occurred via scientific articles obtained in publicly accessible databases, namely springer and google scholar.

1. Review a set of literature contributed to the importance of three KPIs in this thesis project, sustainability, cost, and OTD. For this review, the keywords "the importance of cost and OTD in freight transportation", "environmental impact of logistics structure", "application of sustainability in freight transport", "transport mode effect on sustainability", and "sustainable transport planning" are searched and the most relevant studies are reviewed. All founded studies are written in English.
2. Review a set of literature contributed to different methods for designing a decision-making business process for involving sustainability as the dominant KPI in transport and come up with the design gap. For this section, the keywords "Scientific design methodology", "multi-criteria decision-making in transport", "design a sustainable decision-making system for chemicals transportation", "instruction for adding sustainability into the transport", and "decision-making model for sustainable logistics" are utilized and among findings, the most suitable articles are used for the literature review. Also, all of the reviewed pieces of literature are written in English.

2.4 Thesis Project Framework

Figure 2.2 shows the thesis project framework. For accomplishing this thesis project six phases are defined in the middle of the figure. The 9 chapters and relevant activities in each chapter are mentioned. Also, the Project sub-activities (PSA) and project questions (PQ) are mentioned in the figure.

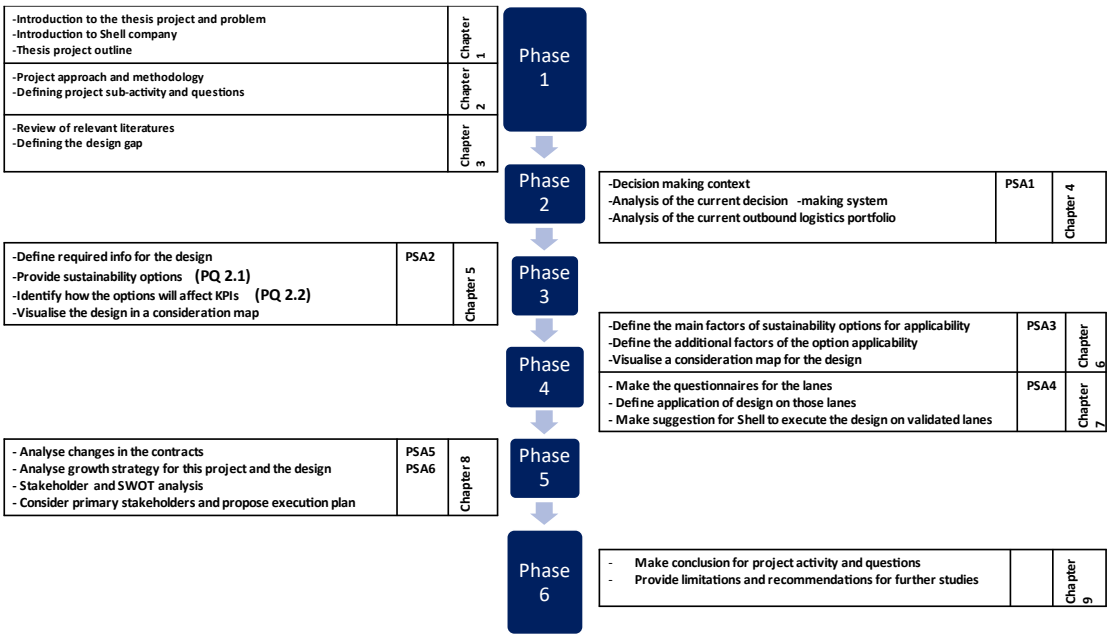


Figure 2.2: Thesis project framework

2.5 Sub-conclusion

In this chapter, the project objective is provided to investigate the available sustainable logistics options for the customers and design a decision-making business process by which the options could be investigated for applicability and assist Shell in selecting the transport options. The project approach is the design approach. For this approach, the adjusted BPDM methodology is used and accordingly the project sub-activities and questions are drawn. This project encompasses 6 project sub-activities that are described in this chapter. A background study setting for reviewing the relevant literature for emphasizing the importance of KPIs and resulting in the design gap is provided. In the next chapter, this setting is executed and relevant studies are reviewed.

3 Background Study Review

In the previous chapter, the approach, methodology, and project sub-activities and questions for accomplishing this thesis project are presented. Also, according to the project methodology, in the problem definition stage, the relevant kinds of literature have to be studied to emphasize the importance of the considered KPIs in this thesis project and to come up with the design gap. This is presented because this project fills this design gap by providing the decision-making business process. A setting involving two sections is provided in the previous chapter for background study reviewing. In this chapter, this setting is executed and the founded pieces of literature are discussed. The pieces of literature are provided Chronologically (according to the date).

3.1 Literature review for emphasizing the importance of the considered KPIs

In the first section, a set of literature that is used for emphasizing the importance of three KPIs in this study, sustainability, cost, and OTD are mentioned.

In the dissertation conducted by Wan Liu (2016) the importance of a couple of factors in freight transportation is examined from the customer perspective. According to this study cost and on-time delivery (OTD)[13] are the most important factors among the six measure factors. CO_2 emission reduction in transportation is the factor with the least importance. This study is used to take insights into this project about the importance of KPIs. Since the mentioned factors and the customer reaction and willingness for accepting them are an important part of this project and the customers will be affected severely by the design execution.

Recently freight transport has confronted different technical, operational, and even political challenges regarding controlling the sustainability and GHGs released from the product transportation. In the study conducted by Tavasszy and Piecky (2018), the importance of sustainability is emphasized and some studies relevant to different approaches for adding sustainability to freight transport are reviewed. These studies show that concerns about the impact on the environment and climate change have increased. The majority of companies in different industries are researching and planning to restrict or remove the CO_2 footprint in their logistics process as one of the core activities in the firms' operation to cut back their role in global warming (McKinnon, 2010). This study is reviewed for taking insights into this project since different sustainability measurements and their impacts on the transport system are the core of this project that is proposed by Shell's hauliers and the impact is part of the consideration of the design.

Bergantino & Bolis (2008) argue that on-time delivery is an important service attribute for the customers when the lower polluting logistics option such as short sea channels are selected instead of road transport. This study is accomplished for the logistics providers in the south of Italy. This is a practical study since the variables of price, time, reliability, frequency of the shipments, and the distance to the customer are considered and for each logistics provider the result is provided separately. This study shows that reliability and shipment frequency are the most important factors while planning for barge transport instead of trucks. So, it emphasizes the importance of OTD for intermodal transport in this project.

3.2 Literature review for the decision support systems

In this section, the kinds of literature relevant to different methods of decision support systems and the studies for making the decision support systems are reviewed to conduct the design gap at the

[13] Reliability KPI

end. The important KPIs in each study are reviewed and the reason why the study is utilized and the place where the study is applicable in this thesis project are mentioned.

The sustainability of the supply chain in the oil and gas industry is investigated by using the BWM method from MCDM in which the stability of the economy followed by market competition are the most important factors affecting the transition to a sustainable supply chain (Sadaghiani et al., 2015). This method is also used in the selection of the supplier in the study conducted by Rezaei et al (2016) in which from the potential international suppliers the qualified ones are selected and prioritized.

Gholizadeh et al (2020) have developed an environmentally sustainable model for a supply chain with the objectives of minimization of costs and information fraud and maximization of transport efficiency. The cost of the information loss is studied which leads to customer dissatisfaction. Big data and nonlinear programming are utilized in this study to develop the model by computational steps. A program modeling for data in logistics is developed which is not the case in this thesis project. Also, it is mentioned that in the real environment the uncertainty is high and due to the nature of the companies and the elements for the product features it is not applicable to apply to all of the settings. However, this study is reviewed for taking insights into the design of the decision-making business process in this thesis project.

In the study of Qaiser et al (2017), 40 articles on the decision support systems in sustainable logistics are reviewed. A bibliometric analysis of authors, keywords, and affiliations investigation is applied to the articles, and as a result, it is shown that the decision support system for sustainable logistics is evolving at a slow pace and it is still an emerging field.

In the case study conducted by Abbasi & Nilsson (2016), it is argued that customer desire and OTD are the biggest challenges that the logistics service providers encounter when making the logistics sustainable. This study is utilized to take more insight into OTD criteria that can be affected by utilizing sustainable transport. The mitigation way of negatively affected OTD KPI is defined as earlier order placement that is utilized in this thesis project in eth validation questionnaires.

Lam & Lai (2015) have developed a decision-making business process for shipping companies to attain their environmental sustainability operations via calculations in the decision algorithm applied in a case study on water transport. This model introduces the incorporation of customer expectation as a dominant concept with the aim of obtaining environmental and market-oriented outcomes. These expectations are identified and prioritized by this decision-making tool. This study is reviewed for this thesis project for discussions with the senior sales managers regarding the design and containing customer desire. However, customer expectations are not the main focus of this thesis project.

In the study conducted by Boutkhoum et al (2015) the fuzzy logic of the MCDM in combination with the online analytical processing data cube model (prioritizing and selecting the most suitable option) is applied to the green logistics in an industrial area in Morocco. Three criteria of the economy, social and environmental issues are considered. According to this study, the environmental criterion is the most important. The logic of the fuzzy model is selected to be used in this study which is not applicable to be applied on this thesis project. However, this study has provided a good understanding of the complexity of developing a decision-making business process containing sustainability.

Boonsothonsatit et al (2015) have developed a generic decision support system based on the optimization of the multi-objective design of the green network in the supply chain for the decision maker who considered cost, short lead time, and sustainability into account. This model shows the best-fitted plant location for the supplier, partners, and customer and transport mode. The Generic

decision support system based on multi-objective optimization for green supply chain network design is integrated with the fuzzy goal programming and exact algorithm calculations. As stated in this model the lead time, price, and environmental sustainability have respectively the highest weight. This study is reviewed for this thesis project to obtain insight into the importance of the three main KPIs.

Zhao et al (2014) have developed a decision support model for hazardous material transportation by train in China for reducing the environmental effects of any accidents. The transport management criteria and risk criteria are incorporated into the design to provide a functional framework for this study. This study is focused on just rail transport and hazardous products. This study reminds the importance of safety that needs to be considered when selecting a transport method. Since some chemical products are categorized as dangerous and hazardous products this criterion is considered in the design.

According to Smokers et al (2014) using sustainable transport options requires high initial prices despite being cost-effective in the long term. In this study, it is mentioned that high initial cost is one of the reasons why developing sustainability is growing at a low speed. This finding is utilized in this thesis project for making the validation questionnaires of the design. Therefore, the acceptable price of sustainable options is asked in those questionnaires.

Abbasi & Nilsson (2012) argue that cost, complexity, uncertainty, and cultural mindset are the big challenges for switching to a sustainable supply chain. In this study, some elements are introduced to be considered for planning sustainable logistics such as management issues, green activity policy and strategy, and different options for making the logistics sustainable such as fuel emissions. Mentioned elements are very broad and considering them is not applicable for this thesis project. However, this study is reviewed for taking insights on important elements as an initiative in the design.

Aronsson & Huge Brodin (2006), has reviewed a couple of case studies in which the transport structures and effect on emission reduction are investigated. In this study, intermodal transport is mentioned as a practical option for making transport sustainable. However, the consolidation of the shipment such as safety and OTD might be affected negatively. In this study lack of theories for connecting the logistics decision to the environmental impacts is mentioned as the intensive lack of interest of the logistics companies contributes to environmental issues.

Geffen & Rothenberg (2000) argue that a close partnership between the supplier and the customer improves acceptance of the innovative sustainable options in the whole supply chain. This study is focused on the automobile manufacturing industry and the role of collaborations in the sustainability of product manufacturing rather than logistics. Although collaboration is considered an effective element for the success of the decision-making model, it cannot be directly used in this study for generating the design. Also, this study does not introduce a generalizable model on how to add collaboration into the decision-making design.

3.2.1 Design Gap

According to what is stated in the reviewed literature just small insights for the design could be taken from the previous studies and none of them can be used directly in this thesis project to make the design. Different methods for developing the design are reviewed in the literature. Nevertheless, a few papers have conducted a relative decision model and due to the specific requirement and features of the Shell C&P land logistics team and the hauliers, they cannot be applied to this thesis project. Therefore, there is no explicit instruction for the Shell land logistics team on how to decide about the applicability of low carbon emission transport methods balancing CO_2 emission, cost, and OTD in the transportation of the chemicals to the customers and the mind mapping method needs to be used to capture the required info for conducting this project. As it is mentioned before, this

project is the first step of the department for developing sustainable transport and there is no evidence and document on the way how factors interact to determine the applicability of an option while balancing the three main KPIs, mind mapping is beneficial to be used in this project. This project is specifically done for the Shell C&P land logistics team to fill this gap and take the first step in the sustainable logistics journey.

3.3 Sub-Conclusion

This chapter aims to discover the design gap as it is a required element for developing the decision-making business process. There exist a few pieces of literature on the decision support models for the sustainability, sustainability of the logistics, and logistics of chemical products. The defined problem of Shell is a specific problem experienced by the land logistics team. So, there is no explicit instruction for evaluating the different sustainable logistics options (transport methods) based on their different features for the application. Nevertheless, the reviewed literature provides a great insight into some of the requirements and conditions in which the sustainability option becomes applicable. Hence, this project aims to shrink this design gap for Shell and provide them with a decision-making business process via the mind mapping technique to be applied on representative lanes in this project.

4 Current process of assigning transport methods and outbound logistics analysis

In the previous chapter, the background studies are reviewed and the design gap is defined as not existence of explicit instruction for designing a business process that fits Shell C&P department, hauliers and customers. In this chapter, the second stage of the adjusted BPDM design methodology is stated. This chapter satisfies project sub-activity 1. The current process that leads to assigning the transport methods to the lanes is analyzed in a generic decision-making flowchart and with more detail a decision-making tree. This process is visualized to make the process more understandable. Subsequently, the current outbound logistics portfolio is analyzed and detailed points for the lanes are mapped. The definition of a lane is an important concept since the current process of assigning transport methods to the lanes and outbound logistics analysis shows the information of the lanes and it is defined in this chapter.

4.1 Definition of a lane

A lane is defined as the specific product loaded from a specific loading site by a specific haulier that utilises a specific transport method toward a specific customer in a specific country and city. The entire project is based on representative lanes that are described in the following.

4.2 Decision-making context

In this section, the context of the decision is presented entailing multi criteria decision-making (MCDM) steps. These items need to be considered to have an optimal resource allocation for data collection, facilitating clear analysis and recognition of uncertainties for the design. The key players in the decision-making are the hauliers and the land logistics team. In this project, the sustainability option in a lane is the unit of analysis, and the design is made for each lane according to the options' main factors and additional factors that are described in detail in chapter 6. According to Sabaei et al., (2015) since the decision in this project is the MCDM, six elements have to be defined for it as follows:

- First, the problem has to be defined. What the land logistics aim to be accomplished in this project is utilizing historical data considering the pre-determined blocked hauliers for specific lanes from the current setting and investigating the available sustainability options offered by each haulier for that specific lane to come up with applicable options for that representative lane. In other words, there is no instruction on how to select the most applicable transport method balancing KPIs of sustainability, cost and OTD.
- Then the requirements for the design of the decision-making have to be identified. These requirements are identified in form of good-to-know and nice-to-know information provided in sub-section 4.2.2. The way how this info is achieved is shown in sub-section 4.2.3.
- Setting the goal is the next step for having a MCDM. The goal is defined as the project goal for designing a decision-making business process. The objective is to provide instruction on how to decide and select the most applicable transport method option for a lane balancing the three KPIs in this project.
- Various alternatives are defined as different sustainability options that are available for a lane. They are alternatives that can be decided upon each other and the criteria are defined as the KPIs of reduced CO_2, cost and OTD and many other factors identified in this project for the different alternatives. Alternatives and criteria are described in table 4.1. For making this table some guidelines from the study of Sabaei et al (2015) are utilized.

Table 4.1: Alternatives and Criteria of the MCDM in this thesis project

Alternatives (Different sustainability options)	Criteria (KPIs)
Fuel change (HVO[14], LNG[15] and Bio-LNG)	CO_2 reduction (sustainability), cost and OTD and many other factors that can apply to a specific lane (provided in chapter 6).
Electric trucks	
Payload increase	
Renewing trucks	
Intermodal transport	

The alternatives are any kind of sustainability options such as fuel change, electric trucks, etc. Depending on each haulier for each lane the available alternatives are different. For some lanes, there might be one and for other lanes there might be more than three options available.

The criteria are defined as the KPIs in this study. Sustainability (CO_2 reduction), cost and OTD are the KPIs considered in this study. However, it emerged that these KPIs are not the only factors that determine the applicability of an option for a lane. For each lane different types of factors play roles besides three main KPIs which are profoundly investigated in chapter 6.

- The last step is to identify the decision-making technique. As it is expressed before, for each lane there might be one or more sustainability options available. So, the number of options for each lane differs. Also, the KPIs do not apply to all lanes and options equally. For example, OTD is not affected by all of the options for all lanes. Also, there are other factors than these three main KPIs that can affect the selection of applicable option for a lane and they are not equally spread for all of the lanes. Some factors only apply to one lane and some others to other lanes. Therefore, the factors and their interaction with the options and lanes are complicated and mind mapping in direct discussions is selected to be used for designing the decision-making business process. In chapter 6 this method is applied and mentioned profoundly.

4.2.1 Decision maker

The design of the decision-making business process improves the process that results in assigning the transport methods to the lanes. The first party involved closely in the development of the design is the Shell land logistics team of the C&P HSSE & logistics department. Therefore, the land logistics team is one of the key players and the decision maker who decides about the most applicable transport option that fits Shell's desire and the customers the best.

4.2.2 Required information for the design

The information required for designing the decision support is data from the Shell land logistics team and hauliers. The info from the land logistics team encompasses the current decision-making system and lanes information. The other important required data is from the hauliers about the sustainable logistics options, their requirements, and consequences for the KPIs, the certainty of the options they provide, and time-framework for option execution. Since this project is the first step toward the team climate goal this data from Shell and the hauliers is the primary data to be collected from them.

Outsourced logistics service providers

The logistics service providers give service to the C&P department for transporting chemicals to the customers and Shell does not possess and utilize its own transport for product delivery. Therefore, for collection of the data connection with haulier outside of Shell is considered.

[14] Hydrotreated Vegetable Oil
[15] Liquified Natural Gas

Need to know and Nice to know information for the design

To be able to design an applicable decision-making business process, distinguishing "Need to know" and "Nice to know" information is essential to be obtained from the Shell land logistics team and hauliers as key players (Legault, 2022). The objective is to represent the necessity of the data for the design. In this project, the data are prioritized by this categorization into two groups as mentioned in table 4.2.

Table 4.2: Need to know and good to know information from the hauliers and the customers required for the design

Design	Shell	Need to know	• Customer and its location • Haulier • Loading site	• Product • Price •Transport method
		Nice to know	• Number of shipments	
	Haulier	Need to know	• Haulier's ability to provide sustainable transport options • Different sustainable logistics options for a lane	• Affected OTD by relevant sustainability option • CO_2 emission of currently and after sustainable option • Logistics Price increase for the sustainable option • Certainty of the option
		Nice to know	• Technical requirements for the options	• Time framework and certainty for the option execution

CO_2 emission presented by the hauliers

There are different methods by which the CO_2 could be calculated by each haulier. However, the most popular software utilized by the hauliers is EoTransIT in which the transport mode, the loading and destination points, vehicle type and its load factor, empty trip factor, and network attribute information are utilized by the hauliers to provide the most accurate CO_2 emission for a lane (EcoTransIT World Emission Calculator, 2020).

4.2.3 Flow activity for info collection

The info from Shell land logistics and hauliers is collected in the style shown in figure 4.1. This figure is the UML[16] activity diagram in which the main entities involved in collecting the data and the process flow of how data is collected are shown. The sequence of data collection shown in the UML diagram is important that has to be satisfied to obtain valuable information and subsequently more reliable analyses.

[16] Unified modelling language

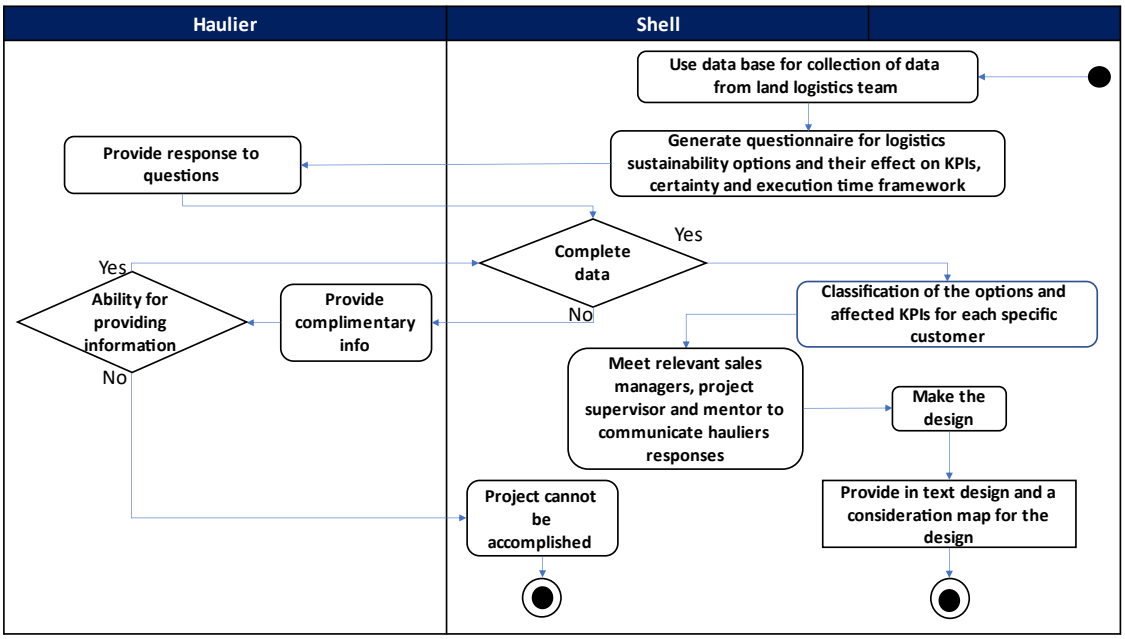


Figure 4.1: UML activity diagram for capturing required information for the design (Own figure)

This diagram emphasizes the important role of the hauliers in providing information and in case of not ability for providing the required info mentioned in table 4.2 the project cannot be accomplished. The process of info collection in this figure is shown in the standardized unified modeling language (UML) encompassing diagrams for visualization of the dynamic nature of data collection flow in a series of activities. It models the control of the flow activity by activity in the business processes. Compared to different models of UML diagrams, an activity diagram is the most appropriate method to be used in this project. A class diagram does not comply with the aim of this visualization since it visualizes the objects and the static relationship between them in a system (Dumas & ter Hofstede, 2001). The component diagram shows how the different components of a system are wired together for generating the bigger component and the deployment diagram depicts the physical aspect of a system which is not the case in this project. In the shown diagram the loop for controlling the completeness of the data from hauliers took a lot of time. This diagram is a type of behavior diagram since it illustrates the steps that must be taken in modeling the data gathering (Dumas & ter Hofstede, 2001).

4.2.4 Limitation

The limitation of the decision-making business process is the dispersion of the data in Shell and hauliers. Accessing the hauliers' data, as well as communicating the right criteria with sales managers are the constraints of the design that need to be tackled wisely. Also, there are other important factors apart from the option and mentioned KPIs that can affect the applicability of the options in different lanes. These factors identification relevant to what occurs in reality for Shell is difficult. In gathering correct and sufficient information from the hauliers there are some limitations. Since the data is sensitive data from the logistics companies for their prices and real numbers relative to their CO_2 emission calculating and providing them takes time. Moreover, there might be some other service providers (4PLs) behind the main haulier that prolongs the data collection process.

4.3 Analysis of the Current process that leads to transport method assigning

Analysis of the process that results in assigning transport methods to a lane is an important step toward the design. Since the decision-making business process is an improver for this process it is essential to investigate how currently the transport methods are assigned to the lanes.

For better understanding firstly the generic decision-making system of Shell C&P land logistics from pre-order receiving to order delivery is drawn in a flow chart and where the design affects this system is shown. Subsequently, a narrowed look at the process that result in assigning transport methods to the lanes is specifically illustrated in form of a decision tree.

4.3.1 The generic decision-making system of transport assignment

In this part, the decision-making system that the Shell land logistics team currently utilizes to assign transport methods for delivering products to the customers is visualized in a flow chart shown in figure 4.2. There was not a documented procedure for a clear picture of this decision-making system at Shell. This flow chart is drawn from personal discussion sessions with the transport coordinator interviewee P3, and land logistics contract managers interviewee P1 and interviewee P2 at C&P HSSE & logistics department. This flow chart is verified by the external supervisor at Shell and it is a complete chart that depicts the processes from the haulier interest for cooperation with Shell in pre-order receiving to the delivery of the product to the customer.

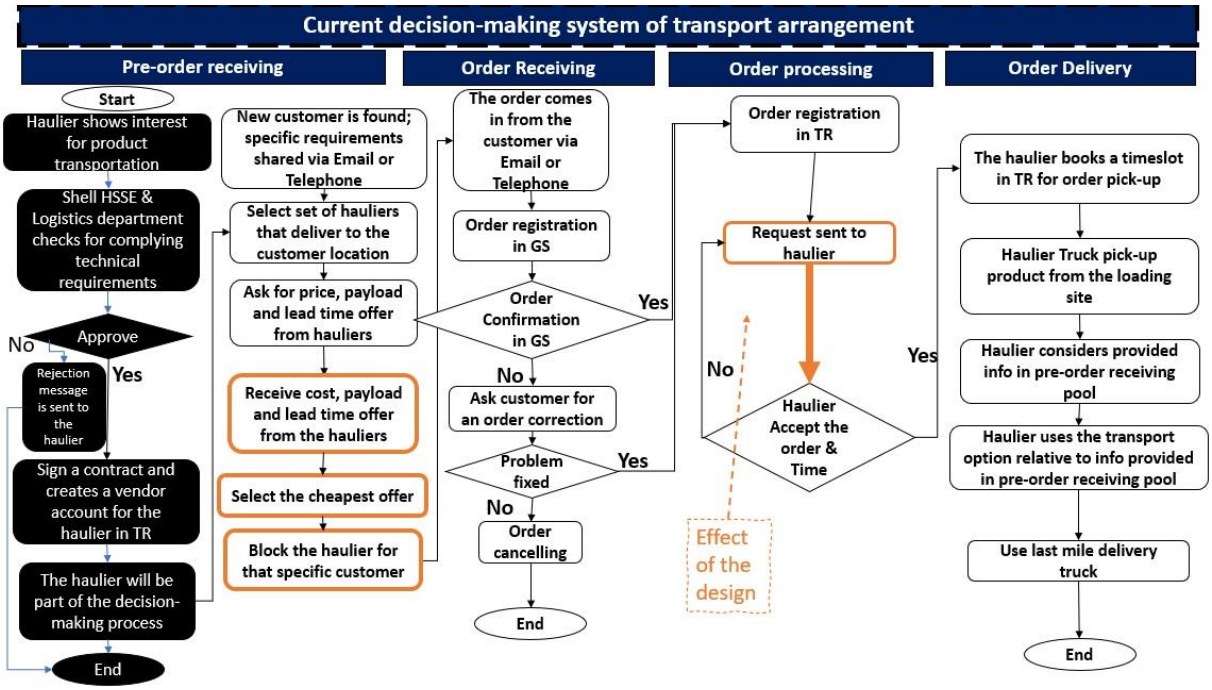


Figure 4.2: The current generic decision-making flow chart for transport assignment
(Own figure)

The performance of the current generic decision-making system of transport arrangement is divided into four pools. The system starts with Pre-order receiving and encompasses the steps taken before an order is received from the customers. Then there are the pools of Order receiving, Order processing, and Order delivery described as follows

- **Pre-order receiving**

This pool encompasses two sections, the black rectangles show how the hauliers for the first time are registered in the Shell system. The hauliers show their interest in cooperating with Shell. Then they are asked to provide their capacity and other technical and safety requirements to achieve approval from C&P HSSE and the Logistics department and be part of the transporting system. After this

approval Shell makes a vendor account in the TR[17] for that haulier and after that they are part of the decision-making system.

The other section shows the steps that are taken for the first time taking a customer and make a haulier responsible for that customer. When new customers are found their desired product and any specific requirements such as delivery location and the amount of product they need are received via email or telephone and registered in the TR. The hauliers that are already part of the system are involved from this stage. The hauliers that are able to deliver to the customer location are asked for the price, lead time, and payload[18] offer. After receiving the reply from hauliers, for acceptable lead time and payload, the cheapest haulier is selected. That haulier is registered and blocked in the TR system to deliver in that specific lane through the customer location. If the customer orders more than one product the same responsible haulier delivers the products to that customer. The transport method is involved in the haulier offer and haulier selection leads to assigning a transport method to a lane. In fact, Shell does not select directly for the transport methods and only three mentioned factors are taken into account as shown in the figure.

- **Order receiving**

In this pool, the product is ordered and any specific requirements regarding the order are attached to the order description. Then the order is confirmed in GS[19] which is considered a powerful tool by which Shell manipulates timelines and business flow processes directions. If the order product type, and desired technical and date requirements are confirmed in GS, it proceeds through the order processing pool. Otherwise in communication with the customer the correction occurs and the process proceeds through the order processing pool. If the correction is not successful the order will be canceled which occurs seldom.

- **Order processing**

This pool starts when the order is confirmed in GS in the previous pool. In this pool, the order is registered in TR. Then the request is automatically sent to a specific haulier determined in the pre-order pool shown in the orange rectangles of the first pool. Currently, there is no request for sustainable delivery and with the design of the decision-making business process, the request for green delivery will be sent to the haulier. When the haulier accepts the order the process proceeds through the order delivery. In case of rejection that can happen due to the delivery time which occurs rarely, another haulier will be requested for delivery.

- **Order delivery**

The order delivery process starts with the reservation of a timeslot for product pick-up by the haulier in the TR. The haulier picks up the product and delivers it to the customer's location by its specific transport method.

4.3.2 Payments

According to what is discussed with the land logistics contract managers in the Shell C&P HSSE & Logistics (Interviewee P2, personal discussion, Apr 20, 2022) the payments happen [redacted] times per month with [redacted] days payment term with the hauliers. Two of them are for the regular shipment payments every [redacted] weeks and one variable additional cost that is due to any incidents and specific care of the product not mentioned in the contract. This additional cost is registered as an invoice[20] in

[17] TR: Internal system of Shell by which the order data will be visible for Shell, haulier and customer
[18] Payload: The amount of the product that is loaded on the transport mode to be delivered to the customer
[19] GS: It is an ERP[19] modular software that integrates the main business performance of the Shell into a unified system
[20] Invoice: A document stated the value of the transactions between Shell and the customer involving the product and logistics costs

the TR. When Shell accepts this invoice it is sent automatically to the Shell ERP system and monthly bills are made out of them for the customers. The customer payment does not occur for each shipment separately. For PODer, Solvent, and Heavy olefins group the payments occur every [redacted] days while for Styrene it involves a range from [redacted] days to [redacted] days depending on the products in this group.

This strategy is a standard strategy determined by the policy makers for the payment terms in the financial department and they will not be affected by the design in this project. In some of the contracts with the customers, the logistics has its own term and the customer is aware of the logistics price separately from the product and in some other contracts, the logistics term is not separately mentioned. However, the logistics price is a small portion of the total price that customers pay in payment terms. It is because the chemical products are valuable and margins[21] are high. Therefore, the share of the transport from the total price is small compared to the other costs such as the product itself. This matter applies to different product lines such as PODer, Solvents, Heavy Olefins, Styrene, and HOder involved in this project. This matter is used in chapter 8 in the implementation proposal chapter for suggestions for better negotiation planning with the customers.

4.3.3 Where the designed business process fits in the generic decision-making system

Via the decision-making business process, the method by which the product is delivered to the customer will be changed. Since Shell does not select the transport method directly there is not any specific term and procedure for this selection in the flow chart shown in figure 4.2. However, the orange box and arrow in the order processing pool show where the design will have an effect. It entails that the request for sustainable delivery will be sent to the haulier in this stage and after acceptance by the haulier the product will be transported with lower CO_2 footprints. However, this process is not as easy as it looks. In chapter 8 the essential steps for implementation are described.

4.3.4 Current Decision-making tree of transport arrangement

In order to better comprehend and present a more detailed vision of the haulier selection that leads to the allocation of a transport method to a lane, a decision-making tree is mapped to show how the selection of a haulier and blocking it for a customer leads to assigning a transport method to a lane. This tree illustrates briefly the content of the decisions that are difficult to show in the flow chart diagram. It is tried to simplify the process in a representative decision-making tree and this tree is verified by the project's second external supervisor. The benefits of the decision-making tree used in this project are as follows:

- Decision-making tree provides more flexibility in adding concepts that are desired for the design (Smart Draw, 2022).
- The decision of Shell HSSE & logistics for selecting the haulier is a complicated decision and the tree makes the communication of the process more effective.
- This tree provides a good vision of the data regarding the current and future decision-making system (Smart Draw, 2022).
- Choices, objectives, and gains of each step in the process are clarified and a comparison with the new situation is performed more efficiently.

Figure 4.3 shows an illustration of the current decision-making tree in a general overview by combining the main elements from the generic decision-making flow chart shown in orange rectangles provided in figure 4.2.

[21] Margin entail for the profit margins of the products

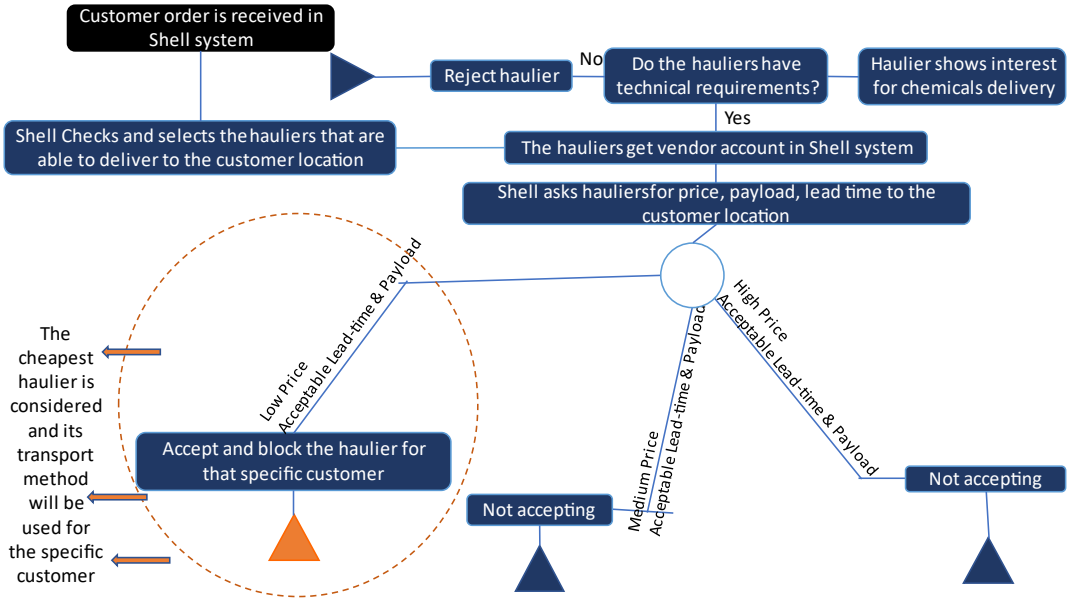


Figure 4.3: The current decision-making tree of transport assignment
(Own figure)

4.3.5 Conclusion about the current transport method selection

Analyzing the flow chart and the decision tree shows that the transport methods are not being selected directly by Shell. That is the reason why there is no specific term in the flow chart and tree about transport method selection. After considering the hauliers that can deliver to the customer location, and selecting the cheapest haulier for acceptable lead time and payload, that specific haulier is responsible for that specific lane toward the specific customer for delivering the product. Then the haulier utilises its transport method to deliver the product and Shell has no consideration for it.

4.3.6 What will be different in the decision-making tree after the design

The decision-making business process improves the decisions made for chemical transportation to European customers. Improving entails adding a decision-making process into the current system for selecting appropriate transport methods for the lanes balancing KPIs. Since for this project Shell is not aiming at adding any new haulier and customer into the system or switching between them and it is willing to keep the setting of hauliers and customers the same as now, the blocked hauliers for specific customers are considered which is elaborated in generic decision-making model of figure 4.2 (Interviewee P1, personal discussion, March 17, 2022). The reason for this consideration is provided in section 4.3.8. As stated before there is not a procedure for transport method selection and by design, this procedure is made and added to the current system. Hence, where the decision business process starts is considering blocked hauliers for the lanes shown in the orange dashed circle in the decision tree figure 4.3. With the assistance of the design, the haulier will be asked to deliver sustainably toward the customers for the lanes they cover. By the design, the only thing that will be changed is that the hauliers will be asked to deliver in a sustainable way to the customers and the lanes they cover.

4.3.7 Why land logistics team is willing to use already assigned hauliers for lanes

The reason is that before hauliers are assigned for specific lanes and customers it cannot be generally asked from them for available sustainability options since the customer location circumstances in terms of accessibility to rail, road, and water, distance, and the transported product are important metrics as well as the haulier initiative for providing sustainable logistics. Also, the entire process of haulier blocking for a customer containing technical information from the hauliers requires a long

time and it is not the scope of this project. In addition, in the contracts of Shell with the hauliers, the covered lanes are mentioned. The lengths of the contracts are 3-5 years and in this contract time, it is not possible to change the lane for a haulier and switch hauliers between lanes that are not covered in the contracts. Moreover, arranging again the hauliers for a lane is time-consuming and the total process for assigning the hauliers to the customers will be reshaped which is not the topic of this project. Furthermore, the land logistics team aims to execute this project very soon, and switching the hauliers and assigning new hauliers to new customers in the system does not allow the project for early execution.

4.4 Analysis of outbound logistics portfolio

There are many customers all around Europe that are delivered Shell chemicals products. Around 700 locations in the entire Europe. There are 21 loading sites in the Netherland where the delivery of chemical products starts from there. There are 4 main product groups that each one involves many specific products in the lanes and 3 different transport methods of direct road, intermodal road-rail-road and road-barge-road. All these data are filtered and explained in the next sections. Thus, it can be imagined how big (20112) the number of lanes is for investigation in this thesis project. To be more accurate with the data processing, avoid unmanageable workload in the scheduling time of this project, receive complete data from the hauliers, reduce complexity, have an exercise in a small spectrum, and by the request of Shell, a set of lanes start from specific loading sites are analyzed for the current outbound logistics that are described in the following. The aim of analyzing the outbound logistics portfolio is to obtain the information from the lanes to be able to fulfill the requirement for the design in the next chapter.

4.4.1 Utilized data and important filters

The data that is processed to pattern the current outbound logistics portfolio is the database for the year 2021. The following points show the Important filters applied to the data collection process and the reason why they are important.

- Incoterms[22]: By the request of Shell and to make the data manageable and relevant, the customers with CPT[23] and DAP[24] incoterms are selected to collect the relevant info from them. These incoterms are determined in the negotiation between Shell and the customers. In both incoterms, Shell pays the transport and risks of the transport. The only difference between these two incoterms is the ownership of the product. In CPT incoterm the ownership of the shipment transfers to the customer from the moment that the chemical is loaded in the loading site and in DAP incoterm the ownership transfers from the moment that the chemical is discharged at the customer location. The majority of the incoterms are CPT and C&P department is planning for changing DAP terms to CPT in the negotiation with the customers in the coming months (Interviewee P4[25], July 14, 2022). However, these incoterms do not affect the design and they will not be changed after the design.

Products: By the request of the Shell land logistics team, products in the PODer, Solvent, Styrene, HOder, and Heavy Olefins groups are considered to be involved in this project. The other groups that contain very hazardous products require special handling and they are excluded from this project scope. The product groups and a description of them are shown in table 4.3 (Shell Chemicals, 2021). A short review of the product specification is applicable for a better

[22] Incoterm: International commercial terms are the commitment of the supplier, customer, and logistical services for their responsibilities and obligations in their transactions such as the risk and transportation costs (Davis & Vogt, 2021).
[23] Carriage Paid to.
[24] Deliver at place
[25] Sales managers Chemicals, Rotterdam Weena.

understanding of the product specification and its use. These product groups encompass different types of safe, dangerous, and hazardous products.

Table 4.3:Products involved in the design of this project and their important specifications

Product Group	Narrative
PODer (Propylene Oxide & derivatives)	Base component for making polyurethanes, paints, Coatings, Adhesives, Sealants(waterproof leisure wear) & Elastomer Foam for furniture, bedding, and car seats. Some products in this group are sustainable bio-based and recyclable.
Solvent	Use: For enhancing the performance of industrial processes, product formulations, and hydrocarbon solvents production The majority of solvents have Hydrocarbon bases which makes it difficult to make sustainable products. Some Solvents products are **dangerous** (Flammable).
HOder (Higher Olefins & derivatives)	Key raw material for detergents for cleaning products and sun creams to plastics, lubricants, and drilling fluids. This group has no available sustainable product.
Styrene	This is an industrial chemical in the plastic industry and synthetic rubbers to be used in the bed of every product. Some products in this group are **dangerous** (Flammable).
Heavy Olefins	Materials for Plasticizers, detergents, and synthetic drilling fluid. This group contains **hazardous** Products (Flammable & toxic).

- Transport method: By the request of the Shell land logistics team the desired transport conditions such as intermodal road-barge(shortsea)-road (bulk[26] containers), intermodal road-rail-road(Bulk), and direct road, are the filters that are applied to the data. The first and last mile delivery of all intermodal transport occurs by truck.
- Loading sites: There are 4 big loading sites of chemical products in the Netherland and the land logistics team is assigned to arrange the transportation of the products from them to the customers. The Netherland is the supplier of approximately 90% of the chemicals to different EU countries. According to the data analysis, loading sites 1, 2, 3, and 4 are the loading sites that allocate the majority of transportation to themselves between all loading sites in the Netherlands presented in table 4.4.

Table 4.4:Important chemicals loading sites in the Netherland

Loading sites	Contribution (%)
Loading site 1	55.90 %
Loading site 2	17.77 %
Loading site 3	5.03 %
Loading site 4	5.82 %

These loading sites are set as the filters to the database. The data is processed afterward for collecting the required information.

- After applying the aforementioned filters, for the shown lanes in the database the customers are prescribed by the land logistics team to be involved in the outbound logistics portfolio analysis. The database from 2021 shows that among 26 European countries where customers exist, a set of customers allocate the majority of orders and delivery frequency to themselves. Therefore, they have a great impact on the emission of the logistics, and compromising them in the design of the decision-making business process affects the emissions remarkably.

After customer selection, the countries and cities where the chemical products are transported to them as the customer location, the product, transport method, responsible haulier, the loading sites, and relevant incoterm for that lane are listed.

[26] Bulk: Considerable quantity of the product in the shipment without packaging that applied to chemical products

4.5 Final remark

In this chapter project sub-activity 1 is addressed. According to what has been analyzed in this chapter in figure 4.2 and more specifically in figure 4.3 about the current decision-making system, it appears that the hauliers are being selected directly in the current decision-making system by Shell considering the cheapest one. The selected haulier uses its transport method and Shell does not directly select for it. There are some advantages and disadvantages to the current decision-making system:

Advantages:

- The payload, lead time, and price are important factors in the consideration for hauliers selection for a lane. According to the lead time, the land logistics team asks for the order placement time from the customer.
- According to this system financially the selection of the hauliers and accordingly assigned transport methods are beneficial for Shell since the cheapest haulier is selected for product delivery
- Does not contain the complex process of sustainability content involvement

Disadvantages:

- The land logistics team does not consider transport method as a factor to select hauliers for the lanes in the current decision-making system
- Haulier selection leads to assigning a transport method to a lane
- The system is lacking sustainability KPI and CO_2 footprint is not tracked seriously
- The land logistics team cannot achieve its goal of 50% CO_2 emission reduction by 2025.

The disadvantages of this system are considered for improvements. Regarding the first disadvantage, the haulier selection process transforming by adding transport methods factors to the current system is not the domain of this project. Sustainability KPI can be added to the system with the assistance of design in this thesis project without changing the process of haulier selection. By the mean of this project, the design is added to the current setting and it contains sustainability as the dominant KPI, the cost, and OTD as the other KPIs affected by sustainability. The CO_2 footprint is trackable with the assistance of this design while it is not considered in the current decisions for arranging logistics. By the mean of this design in this project, the land logistics team is able to take the initial steps towards its goal for 2025.

5 Fulfilment and analysis of the requirement for the design of the business process

In the previous chapter, the current decision-making flow chart and tree for assigning transport to the lanes are described, the effect of the design on the generic decision-making flow chart is described and the step after which the design starts is shown in the decision-making tree of transport assignment. Also, the outbound logistics portfolio is analyzed for lane specifications since they are required to be used in this chapter. In this chapter, the project sub-activity 2 and the third step of the BPDM design methodology are satisfied. The requirements for the design are the available options, their requirements, consequences, certainty, and execution time framework. This info must be fulfilled by the hauliers since the logistics of chemical products is outsourced and Shell has no idea about the availability of the options for different lanes. Therefore, the data is captured from hauliers via questionnaires. For generating the questionnaires, the info from the analysis of the outbound logistics in the previous chapter is utilized, certain lanes are selected to be in the questionnaires to obtain hauliers input for available sustainable logistics options and different options' effects on the KPIs. This way the requirement for the design is fulfilled. In this chapter, all the information in the hauliers' responses is provided and analyzed.

5.1 Steps before formulating the hauliers' questionnaires

Different sustainability options can be provided by hauliers to reduce the transport CO_2 footprint such as using cleaner fuels, electric vehicles, intermodal transport, etc. Nevertheless, each one induces extra costs to the transport. Since the transport costs are covered by Shell associated with the incoterms, initially the land logistics team needs to pay this extra amount for sustainable transport. However, this extra cost affects the customers since it is transferred to the customer contracts and they need to pay for it. Therefore, to be able to design an applicable decision-making business process for the Shell land logistics team the input from hauliers must be obtained about available sustainable transport options and affected KPIs results from each sustainable option. When the lanes are clear for the hauliers they are able to provide options and their effect on the KPIs.

Since the logistics service for Shell chemicals is outsourced by different logistics companies in the Netherland, Germany, and Belgium requirements for the changes in the chemicals transport have to be negotiated with them. To treat the hauliers equally, the questionnaire is selected to be the mean by which the info could be collected from the hauliers for this project. Prior to generating the questionnaires, the idea is discussed with the Commercial sales team manager and the senior account manager at Shell chemicals Europe. The project external supervisors and mentor were also involved as the fixed members to make a concrete questionnaire for hauliers (Group discussion, April 8, 2022).

5.2 Utilised data for making the hauliers' questionnaires

To be able to manage the data, obtain complete responses from the hauliers, and keep the questionnaires short to gain info from hauliers, the data from the analysis of the outbound logistics portfolio is filtered again to select the most important customers for making questionnaires for the hauliers in their lanes. It entails that a couple of customers with the majority of orders amount and frequency from the analysis of outbound logistics are considered and the hauliers' questionnaires are shared with their hauliers. This selection occurred by the second external supervisor and mentor.

5.2.1 The method used for generating and analyzing the questionnaires

To be able to make concrete questionnaires for hauliers according to the project goal, the MARMAC method is used as a guideline and it is modified slightly according to the project specifications for generating a valid and reliable questionnaire. This method is provided by Aleamoni (1971) as an instruction for the researchers willing to tackle the data from questionnaires. In this project, this method is used for generating and analyzing the hauliers' questionnaires.

The reason why the MERMAC model is suitable for this project

According to the project goal of generating a business process for the decision-making process, this model is associated with concrete questions involving all required info concerning KPIs. Utilizing this model assists to design a meaningful questionnaire and obtain immediate feedback from the questionnaire and simplify the interpretation of the replies (Aleamoni, 1971). Also, since the questionnaires are non-behavioral questionnaires for hauliers and specific technical information is required from them, concrete data processing is required to take the deliverable of hauliers' responses and communicate them for the design. This MERMAC model describes perfectly the process of the data.

The target groups for these questionnaires are the experts relative to the action or the question. This method describes perfectly the importance of the input from a target group (Haulier), and the required process to make it ready for the other target group (Shell C&P senior sales managers). An overview of the general steps taken according to this method is illustrated in figure 5.1.

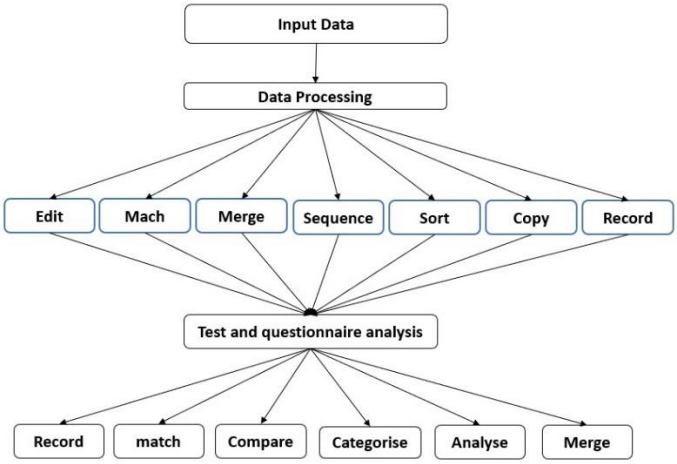


Figure 5.1: MERMAC model for generating and analysis of the questionnaires (Aleamoni, 1971).

5.2.2 List of desires criteria

For the hauliers, the "input data" shown in figure 5.1, is the list of the "desired criteria". A list of desired criteria is generated to take the input in hauliers' questionnaires, Based on this list the questions for the haulier questionnaire are generated.

- Available options for reducing logistics CO_2 emission for representative lanes
- The CO_2 reduction per option (emission are for one way of the transport from loading site to destination)
- The logistics price increase
- Whether OTD is affected/How much OTD is affected
- g CO_2 per km delivery before and after the options
- Certainty of the option and time framework for the execution of the option

Seven utility criteria are considered for processing the desired criteria shown in blue outlined rectangles in figure 5.1. The generated questions containing the desired criteria questions are edited,

checked whether they match the desired criteria list, then the questions are merged, sorted out for the type of the response they are asking that can be in word or numerical required responses also, they are organized in a sensible sequence, questions are copied for all hauliers and recorded in the separate files.

After administering the questionnaires to the hauliers and receiving back the data from them the "test and questionnaire analysis" is the last step conducted for these questionnaires. The responses for each questionnaire are recorded in a specific file of each haulier and checked to match the question's purpose, compared to other questionnaires for types of responses, they are categorized into relevant categories of responses, analyzed based on the desired criteria list and the responses are merged to relevant criteria in the hauliers file.

5.2.3 Type of the hauliers questionnaires

With the aim of making the questionnaire mode original and valuable, avoiding bias in expressing the options being influenced by Shell opinion, and receiving intact insights about available sustainable logistics options the open questions are generated to be used in the hauliers' questionnaires (Foddy, 1993). This project is in the initial stages of progress therefore open questions were appropriate to be asked at this stage (Gilbert, 2001). In addition, since the hauliers are outsourced for chemical transportation and Shell has no info about different options, open questions take any available options and additional remarks from the hauliers. Therefore, the type of questionnaire is "Open Question Questionnaire".

However, some disadvantages are associated with the open questions that made the info interpretation complicated (Reja et al., 2003). In this project the relevant experienced disadvantages are as follows:

- Because the replies types differ per each haulier respondent, the analysis of the responses was difficult and timekeeping
- Existence of non-response questions
- Inconsistent types of received replies

5.2.4 Hauliers questionnaires testing and validation

To mitigate the negative effect of the disadvantages of open questions and since the questions are the fundamental component of data collection from the hauliers in this project, the generated questionnaire is extensively tested 2 times by the second external supervisor, and external mentor. This testing improved the quality and validity of the collected data from the hauliers. Some benefits of this testing are shown in table 5.1 (Johnson et al., 2018). The narrative column shows how the relevant validation is applied to the questionnaires.

Table 5.1: Validation testing of the questionnaires

Checked item	Narrative
Content Validation	Check the intent of each question and the overall structure Transition between questions Question explanation if relevant
Validate data collection protocol	The task of contact with the hauliers The task of presenting hauliers the questionnaires Follow-up tools such as Email and phone number

The testing of the questionnaire for validation is conducted through the content validation and data collection protocol.

- Content validation: This is one of the validation methods applied on the hauliers questionnaire. All the questions are reviewed to check their relevance to the topic. For this aim "desired criteria" list is considered by which the questions are examined to whether they reflect the items in the list provided in section 5.2.2. Accordingly, it assures that the measurement corresponds to the list (Abdollahpour et al., 2011). This validation is accomplished in the matching and merging of the utility criterion step of the MERMAC model.

  In the content analysis the overall structure of the questionnaire is checked in terms of wording, simplicity, and comprehensively in reflecting the questionnaire's purpose. It can be considered face validation as well. The questions sequence is formed to help the haulier better understand the links of concepts and provide the answers without bias. For instance, the questions start with the available sustainability option, afterwards, the CO_2 footprint reduction by that option and, the price of that option, affected OTD, and g CO_2/km are asked as more narrowed down questions. The questions about the certainty and time framework of the option are discussed in direct discussions with the hauliers. Also, if a question requires explanations prior to asking, it is tried to simplify and get to the point in the most simple way. For instance, it is mentioned that sustainability entails lower CO_2 emission generation and no compensation such as planting trees.

- What is entailed by data collection protocol is the method by which the connection with responders occurs and the way by which data is collected (Elomari & Rhinane, 2019). This connection occurred by email, Microsoft meetings, and direct skype calls with the hauliers. The task of the connection with the haulier is determined to be at the first stage with the thesis project author and afterward in the meetings organized by the relevant contract managers, second external project supervisor and mentor. Also, the student was assigned the tasks in the connection moment such as project explanation, exploring the reason why hauliers input is valuable and hauliers benefit scenarios from this project, presenting the questionnaires, and providing follow-up tools for further connections.

5.2.5 Data collection method

The method by which the data is collected from the hauliers is by emailing them to relevant manager directors of different hauliers companies. However, for any clarification on the questionnaire, skype call, Microsoft teams, or telephone connection is conducted as follow-up tools used in this phase of data collection.

5.2.6 Haulier questionnaires structure

The hauliers questionnaire involves two parts. It starts with a short description of the project, the importance of the hauliers' cooperation in further accomplishing this thesis project, some general info about the questionnaire and data treatment, the emergency number and follow-up tool in case of any questions, and further connection requirements. The second part encompasses 6-7 questions entailing one binary closed question, and 5-6 open-ended questions. The structure of all of the questionnaires for the hauliers is the same and the only specific part for each haulier is the suggestion of a couple of representative lanes to the relevant hauliers for responding specifically for those lanes.

5.2.7 Low response rate prevention

In order to mitigate the risk of low response from the hauliers a couple of measurements are taken as follows:

- Testing and validation of the questionnaire: As mentioned previously in this chapter, validating the questionnaire before sharing was beneficial in reducing low response issue.

- Emphasize the importance of the response: The importance of the responses from the hauliers is expressed in the informative text at the beginning of the questionnaires. Also, one day after sharing the files with the hauliers, a telephone call is conducted to all of them to assure they have received the questionnaire and emphasize the importance of their responses for further development of the thesis project.
- Define a due date for the hauliers to reply to the questionnaires: The hauliers were requested to provide answers to the form within 10 days.

5.3 Analysis of the haulier's responses

As mentioned previously in this chapter, the MERMAC model is the base utilized for data analysis from the questionnaires. The types of data from the hauliers' responses are both types of qualitative and quantitative which both require an appropriate approach to be analyzed trustworthy.

Some required data collected from the outbound logistics analysis in form of qualitative and quantitative data is considered, and it is added to the input provided by hauliers. This info is all set together in form of a spreadsheet named "haulier responses". The required data for each analysis is collected from this final spreadsheet. In this file, the data is separated per haulier and encompasses the same response categories of loading site, destination country, and city, distance Kilometre, the haulier, product, transport method, CO_2 g/km currently, volume, and the number of shipments per year (for 2021), sustainability option, percentage of CO_2 reduction, additional cost for making the transport sustainable, effect on OTD, CO_2 g/km by the sustainable option and any additional comments and notes mentioned at the last column. Therefore, the response categories contain both types of qualitative and quantitative data.

5.4 Qualitative analysis of the haulier questionnaires responses

To be able to gain a reliable analysis of the hauliers' responses qualitative data analysis is used in the categorization and analysis stages of the MERMAC model (Popping, 2015). In order to be able to make a senseful qualitative analysis, coding is presented to be an important step in reaching this aim (Gibbs, 2007). Since the data involves facts, evaluations, arguments, and describes the delivery process, it is useful to make a coding scheme by the effect and nature of the solutions (Aleamoni, 1971). Coding can assist make an organized and structured analysis and the interpretation of the qualitative findings becomes more rigorous and critical.

Coding methodology

To code the data all the responses are reviewed completely. It is because the questionnaires consist of open questions and it is expected that the respondent has answered some strategic points in the other places in the questionnaires (Gibbs, 2018). Therefore, the deductive top-down approach (concept-driven) is utilized to create the codes based on the list of "desired criteria" that was defined before making the questionnaires in section 5.2.2 (CESSDA Training Team 2022; Azungah, 2018). For that reason, the set of the replies that could be grouped because of their relevance to a specific "desired criteria" are grouped even if they are differently worded.

Also, some missing information is collected in separate calls and emails after the due time of the questionnaires as mentioned in the loop in the UML diagram in chapter 4. To make a clear and understandable analysis the coding for the qualitative data is assigned to excerpt the relevant data. The code scheme list is as follows,

1. Product group diversity
2. Transport method
3. Different sustainability options

5.4.1 Product group diversity

The diversity of the products in the lanes that are selected from outbound logistics analysis files for being involved in the haulier questionnaires as representative lanes, is shown in the form of a pie chart in figure 5.2. For making this figure the info about the products is collected from the spreadsheet file of "haulier responses".

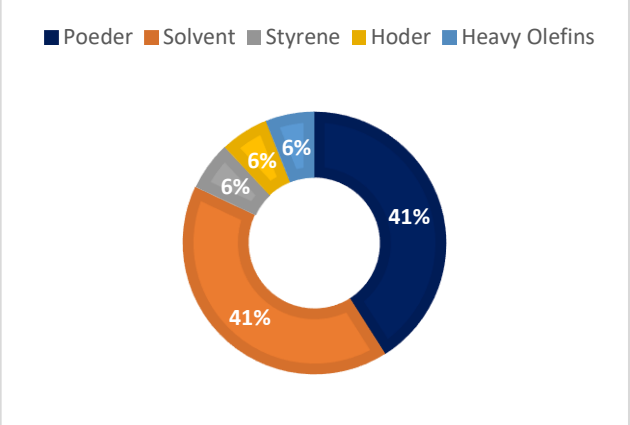


Figure 5.2: Product distribution for selected lanes in hauliers questionnaires

Among selected lanes and transported products in that lanes, it can be comprehended that the solvent and the PODer products groups allocate the majority of the products to be transported to the customers at about 41%. Styrene, HOder, and Heavy Olefins each allocate only 6% of the total products to themselves for representative lanes in this project.

5.4.2 Transport method

The distribution of the current transport methods of the selected customers and their lanes is shown in figure 5.3. The info for making this figure is from the transport method response category of "haulier responses".

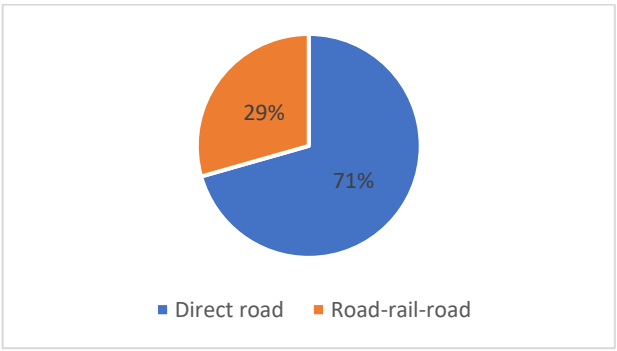


Figure 5.3: Current transport method for selected lanes

As it can be seen from the pie chart the majority of the transport methods provided by the hauliers for the current situation for representative lanes in this project are direct road with a couple of intermodal road-rail-road transport methods. This result is for the involvement of 17 representative lanes selected for this project. In the direct road method, the trucks for delivering chemicals to the customers are diesel trucks that are associated with high GHG emissions.

5.4.3 Different sustainability options

The percentages of different options provided by different hauliers for selected lanes are shown in the pie chart in figure 5.4. The information from the sustainability option response category provided

by the hauliers in "haulier responses" spreadsheet is utilized for calculating the percentages and making this pie chart.

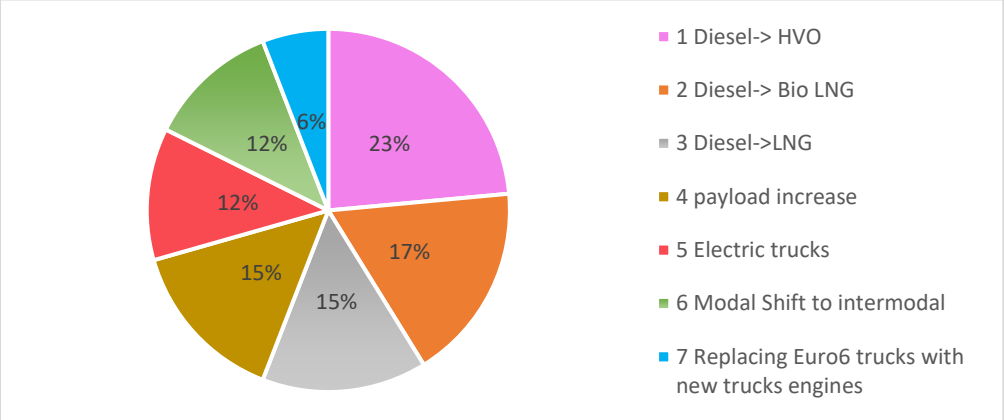


Figure 5.4: Distribution of provided options by the hauliers

As it can be seen from the pie chart, the fuel change from diesel to HVO allocates the majority of the responses to itself at about 23%. The second position is for the fuel change to Bio-LNG at about 17% and the third place is for LNG fuel at around 15%. The payload increase is mentioned as much as LNG fuel is mentioned, at about 15%. Renewing the fleet with new types of trucks with boosted engines allocates only 6% of the total provided solutions to itself. There are some important points regarding the options as follows:

- Electric trucks can be used for the entire lane or the first and last mile delivery that provides a different amount of CO_2 reduction of the whole lane. There is no legal prohibition and requirements for dangerous goods transportation with electric trucks in the legislation by ADR[27] in Europe (Economic Commission for Europe, 2017). Therefore, there is no requirement for an ADR certificate or any inspection. Due to the huge energy density in the trucks because of batteries, the likelihood of using fully electric trucks for long distances is very low. In addition, batteries are heavy, and considering the weight of the vehicle, the payload needs to be decreased. As it is recommended Electric trucks could not be used for hazardous products such as some of the products mentioned in this project. The Netherlands has recommended a set of appropriate measurements that can be taken for danger mitigation such as high voltage system electric safety, battery system fire risk, and hazardous areas safety (Economic Commission for Europe, 2017). This type of vehicle is used seldom for transporting chemical products due to high uncertainty about them. However, due to regulations in the Shell loading sites no electric vehicle is permitted to enter the site and this option cannot be used (Interviewee P1, personal discussion, August 18, 2022).
- HVO fuel can be used purely or in different percentages blending with diesel that gives different levels of CO_2 reduction. The conventional diesel trucks can be used for the HVO fuel. The amount of utilized HVO would determine the price. Thus, the price and the amount of reduced CO_2 are flexible.
- The options of fuel change to LNG and Bio-LNG require specific LNG trucks since these fuels are not compatible with diesel engines.
- For the option of the modal shift from direct road to intermodal in some cases, the volume of the order needs to be investigated since below a specific amount of product the intermodal transport does not work and a huge amount of products are regularly being transported by

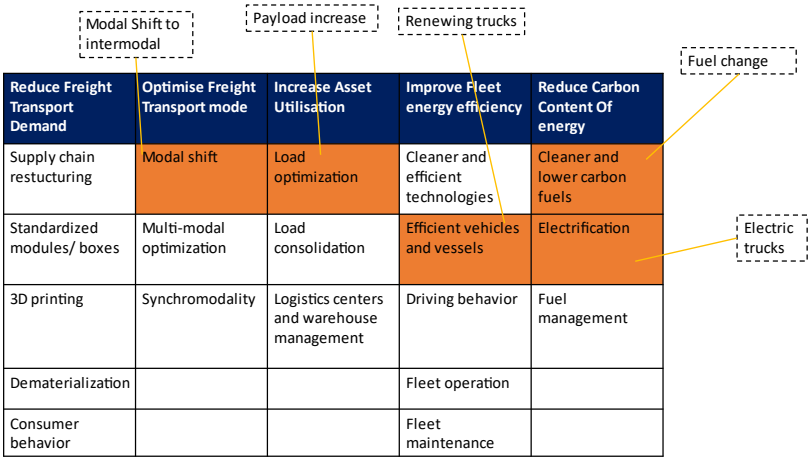
[27] ADR: European Agreement Concerning the International Carriage of Dangerous goods by Road-ADR

barges or trains. The specific information needs to be asked from the rail operators and the customers.

- Accordingly with the payload increase option, the amount of transported product per delivery increases, and the customer will be delivered a greater amount of product in one delivery that needs to be aligned with the customer storages tanks' capacity.
- Renewing trucks occurs when the trucks in the fleet reach their end of life (EOL). The hauliers for this project have provided this option for conventional diesel trucks that their boosted engine releases lower CO_2 emission. Nevertheless, this reduction is not significant. The hauliers are the party who decide about this option and Shell cannot ask it from them or dictate it to them.

5.4.4 Sustainability options in the GLEC[28] framework

The data provided by the hauliers are categorized in the identified options domains by professor McKinnon[29](SFC GLEC, 2019). The logistics sustainability options area stated by McKinnon are transport demand, transport mode, asset utilization, energy efficiency, and carbon content of energy reduction shown in figure 5.5, and the responses from the hauliers' questionnaires shown in dotted outlines rectangles are aligned with the orange cells from this categorization in the GLEC framework. The info required for this comparison is from the previous analysis about the types of the options and reviewing the McKinnon options categorization in the GLEC framework provided by smart freight centre (SFC).



Reduce Freight Transport Demand	Optimise Freight Transport mode	Increase Asset Utilisation	Improve Fleet energy efficiency	Reduce Carbon Content Of energy
Supply chain restucturing	Modal shift	Load optimization	Cleaner and efficient technologies	Cleaner and lower carbon fuels
Standardized modules/ boxes	Multi-modal optimization	Load consolidation	Efficient vehicles and vessels	Electrification
3D printing	Synchromodality	Logistics centers and warehouse management	Driving behavior	Fuel management
Dematerialization			Fleet operation	
Consumer behavior			Fleet maintenance	

Figure 5.5: Provided sustainability options in the GLEC framework
(SFC GLEC, 2019)

As it can be seen, the available options offered by the hauliers, are from the "Optimise freight transport mode, increase asset utilization, improve fleet energy efficiency and reduce the carbon content of energy" categories.

5.4.5 Factors impacting the type of offered options and KPIs

An interpretation of the hauliers' input shows that different interrelated factors can affect the type of sustainability options offered by the hauliers and the KPIs. The visualization of these factors' relationships can better reflect their impact on the type of offered options and KPIs.

Method for determining the factor's relationship

[28] GLEC: Global Logistics Emission Council providing standards for logistics emissions calculations released by Smart Freight Centre (SFC GLEC, 2019

[29] Professor of Logistics, Kuehne Logistics University, Hamburg(Professor Alan McKinnon, 2022)

With the aim of identifying the individual and the pairwise relationship of different factors affecting the logistics sustainability options, an investigation in the Structural Self-Interaction Matrix (SSIM) is conducted (Attri et al., 2013). In this matrix, the factors are listed and the interaction between them is presented. SSIM matrix is part of the Interpretive Structural Modeling (ISM) methodology that is a type of Multi-criteria decision-making (MCDM) method. ISM is an interactive systematic learning model in which the relationships between the elements are comprehensively structured (Nigam, 2014). As mentioned before implementing sustainability projects is entitled to be categorized as a complex issue (Raut et al., 2019). Among the present methods in MCDM, this method is selected to present the relationship final model. Also, there is no requirement for dominant interrelationships between the factors in the ISM model (Raut et al., 2018). Whereas the other MCDM methods such as analytical network process (ANP) are not able to reflect all of the dependencies (Wu, 2008). The other methods such as social network analysis (SNA) and decision-making trial and evaluation laboratory (DEMATEL) prioritize the factors which is not the case here in this project (Abuzeinab et al., 2017). Therefore, ISM is selected to visualize the mutual relationships between factors.

Utilized tool for ISM analysis

The utilized tool for relationship visualization of the factors affecting the type of logistics sustainability option is the software of “Smartism”. For generating the final model of the relationship the following steps are taken.

Step 1: For listing the factors ISM methodology suggests using experts’ ideas in brainstorming sessions (Menon & Ravi, 2021). For that reason, the factors are listed from findings from the hold sessions prior to making the haulier questionnaires with Shell staff containing senior sales managers and project external supervisors and mentor, hauliers’ responses in the questionnaires, emails, and oral information obtained in direct contact with the hauliers via, skype and Microsoft teams. Therefore, organizing open questions and further contact with them has resulted in receiving this complementary information. The list of the factors is as follows:

Affecting factors:

- Corona Crisis
- Existence of 3PL, and 4PL logistics service providers
- Customer location
- Haulier’s willingness/ability for developing sustainability aims
- Different Logistics sustainability options
- Utilisation of the option for part of the lane

Affected KPIs:

- Logistics Price Increase
- CO_2 emission reduction
- Affecting OTD

Step 2: For the establishment of the conceptual relationships of the type “Leads to” is utilized to form the structural self-interaction matrix (SSIM) and after filling this matrix the rest of the data is automatically generated by “Smartism” software.

5.4.6 Factors relationship map

The final model relationship is shown in figure 5.6 in which the main KPIs are shown in brown color.

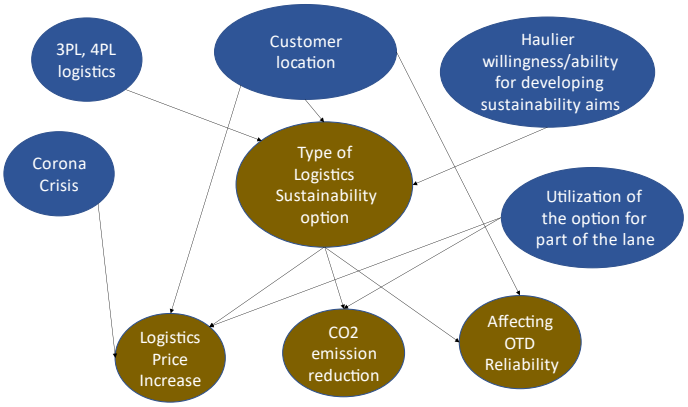


Figure 5.6: Impacting factors on the type of the sustainability solutions and KPIs
(Own figure)

- Making the logistics sustainable requires financial investments and accordingly the price increases. The corona crisis has increased fuel and energy costs. Disruptions in logistics from the corona pandemic have affected this sector negatively and to recover faster the pricing strategy of the logistics will be affected. It applies to the hauliers and Shell pricing strategy for further development of this thesis project in the execution phase this matter needs to be considered after this project (Mordor Intelligence, 2021).
- For transporting the chemical products to the customers in a different location different transport methods could be utilized. However, some of the contracted hauliers with Shell (3PL) are not able to provide some transport options such as intermodal and they arrange it in their connection with another haulier (4PL). So, the capabilities of third-party logistics (3PL) and fourth-party logistics (4PL) impact the transport method types and accordingly any sustainable option that they offer for transporting chemicals.
- Customer location is an important factor in determining the sustainability option. Location entails the location facility for customer access to the road, rail, and waterways. Also, the distance from the loading site to the customer location is the other factor that affects the offers of different options. Moreover, the distance from the loading site to the customer location is an important factor that determines the transport method. For distances up to [redacted] Km direct road method and above this limit, the intermodal way of transport is used (Interviewee P1, personal communication, February 22, 2022). Furthermore, longer distances indue higher logistics prices to the system. As stated by some sales managers, OTD reliability is a concern for customers in longer distances, since the longer distance increases the risks and requires more movement between different transport modes in case of intermodal (Interviewee P6[30], personal conversation, April 20, 2022).
- Some hauliers have fostered sustainable logistics in their fleet and they have already executed the transport with lower emissions. However, some others do not compromise sustainable logistics although sustainability is defined in their business portfolio. As stated by some of the hauliers, they are in the phase of investigation without any executed sustainability plans.
- The type of logistics sustainability option itself induces extra costs to the transport system. For most of the options, the logistics cost increases as stated in the hauliers' responses. The types of options affect this cost increase. For example, the fuel change option cost differs from the electric truck cost, and accordingly their effect on increasing the logistics cost differs. Moreover, as stated earlier some sustainability options such as the modal shift to intermodal can affect the OTD negatively and all of the provided options by the hauliers lead to CO_2 emission reduction which is elaborated more in section 5.4.7.

[30] HSSE advisor, Shell Chemicals HSSE & Logistics department

- As stated by the hauliers and what is discovered from the questionnaires, some of the sustainability options are used for part of the lane, the first and last mile delivery. This matter directly impacts the price increase and CO_2 reduction. For instance, as the spreadsheet file of "haulier responses" shows the electric trucks from haulier B to be used in the first and last delivery to the customer in lane E decreases the CO_2 emission by only 15%, while if it is used for the entire lane the emission could be zero.

5.4.7 Affected KPIs

Each available option provided by the hauliers has its own effect on the considered KPIs shown in table 5.2. For generating this table the data provided by the hauliers about the options, their effect on the price, and OTD are analyzed from "haulier responses" spreadsheet and an average of the price increase and the CO_2 emission reduction by that option is calculated and provided in this table.

Table 5.2: Available sustainability options and their effect on the KPIs
(Own table from the analysis)

N	Sustainable logistics option	Logistics Price	OTD Reliability	CO2 Reduction %
1	Diesel-> HVO	+ 8.315 %		37.66%
2	Diesel-> Bio LNG	+ 2.88%		79 %
3	Diesel->LNG	+ 5.07%		8.85 %
4	Increrase Truck payload	0		4.83 %
5	Electric Trucks	+ 84.61		57.5 %
6	Modal Shift to intermodal	+ 104.25%	●	60.11 %
7	Replacing Euro6 trucks with new trucks engines	+ 8.17%		6 %

Legend
● Decrease

According to the table derived from the analysis of the hauliers' questionnaires, the price of the logistics will be increased for all of the options except for the payload increase. For the options of fuel change to HVO, LNG, and Bio-LNG the price increases since these fuels are more expensive than conventional diesel fuel and for LNG and Bio-LNG, specific trucks must be used. There is no change in the logistics price associated with the payload option since nothing from the logistics perspective alters. Electric trucks increase the price since the battery energy to be utilized as the power for the logistics makes the logistics price more expensive. Modal shift from direct to intermodal affects all of the KPIs, OTD reliability will be decreased and the price will increase. It is scientifically proven as stated by Kubáňová et al (2020) that despite the advantages of intermodal transport of making the lane sustainable, the ability to increase the payload and decrease the delivery frequency, there exist some disadvantages. The relevant disadvantages to this project are as follows:

- Decrease of OTD reliability: It points out the delay in most of the cases because of lower speed in product movement. Since in the intermodal option the chemical product has to be moved between different transport modes that in the case of this project it moves between road-rail-road and road-barge-road, it requires a longer time to arrange this movement safe and secure (Riessen et al., 2015). Chemical products are the type of products that require accurate observations from the HSSE perspective. Making the transport intermodal increases the risk and managing it requires a longer time (Interviewee P6, personal conversation, April 20, 2022).

Renewing trucks in the fleet for lower CO_2 emissions is associated with boosted engines in conventional diesel trucks. This option increases the price of the logistics since the trucks are more expensive than old fashions.

The CO_2 reduction associated with each option is shown in the third column of table 5.2, the payload increase and renewing of the trucks have the least effect on CO_2 reduction. While the modal shift to intermodal, electric trucks, and fuel change to Bio-LNG and HVO have a great effect on emitting lower CO_2.

5.5 Quantitative data analysis

As mentioned before, the hauliers' responses contain quantitative data as well. Below, a list of the numerical data from "haulier responses" spreadsheet is captured and analyzed.

5.5.1 Hauliers that already provide sustainable transport options

According to the input from the hauliers, two of them are providing low-emission transport options to the Shell C&P land logistics team currently. Haulier D and F claimed that they are utilizing intermodal road-rail-road transport and the lanes are already sustainable. In figure 5.7 the performances of these two lanes are compared in terms of the CO_2 emissions.

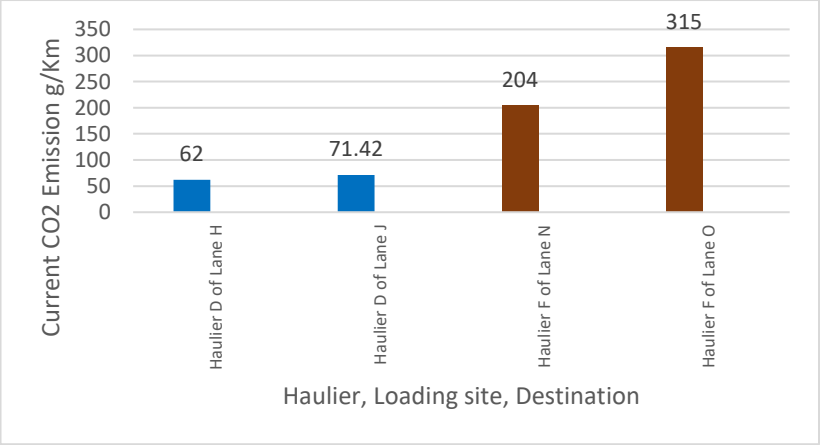


Figure 5.7: Comparison of current sustainable lanes for their CO_2 footprint

Although both hauliers are providing intermodal road-rail-road transport, haulier D has a better performance than F in terms of CO_2 emissions. The reason is that haulier D already utilizes HVO trucks for the first and last-mile delivery. Therefore, the CO_2 emission per kilometre is lower than for haulier F.

5.5.2 Hauliers performance for providing different sustainability options

The data that the hauliers have provided are utilized to have a comparison between different hauliers' performances for providing sustainable transport options. This comparison is provided in figure 5.8 in the column diagram. The information for making this figure is the info provided by the haulier in "haulier responses" spreadsheet about the options they provide. The reduced CO_2 emission is calculated on average for each option.

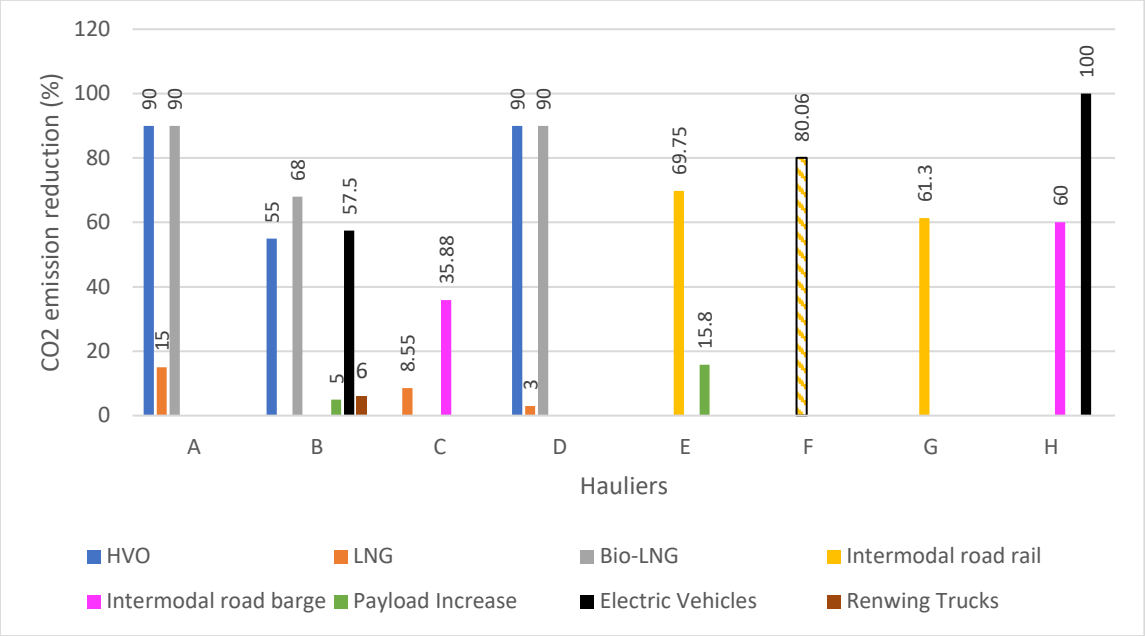


Figure 5.8: Performance of different hauliers in providing sustainability options and the amount of CO_2 reduces by each option

According to the diagram, hauliers A, B and D are able to reduce the CO_2 emission in their transport by the fuel change option of HVO, Bio-LNG which reduces the emission significantly. On the other hand, hauliers B and D are the hauliers that provide options with lower than 6% CO_2 reduction by the payload increase, renewing truck, and LNG options. The column for haulier F with orang dash means that the modal shift to intermodal road-rail-road is the transport method. However, it is dashed because the option is already in use and haulier F utilizes this mode of transport (intermodal) for delivering chemicals to the customer.

The reason why an option differently impacts the CO_2 emission reduction for each haulier is that the distance between the loading site and destination locations differs, the sustainable option could be utilized in the entire lane or part of a lane. Also, in the case of the intermodal road-rail and road-barge the fuel of the train or barge could differ, it can be coal or electrified which significantly impacts the CO_2 emission reduction and no information from these details are available.

5.5.3 The price increase and CO_2 reduction by the sustainability options

Different hauliers have provided different options and different percentages of the price increase. The reason is that each sustainability option has its own price depending on the nature of the option and each haulier has its own policy for determining how the logistics increases. Also, for one option, different hauliers provide different price increases. The factors that affect this difference are:

- Different haulier's internal defined tariffs for the lane
- Distance from loading site to the customer location
- Price of the transport logistics in different countries, for instance in Switzerland trucks delivery is very expensive.
- Different products require different technical equipment during the transport which affects the logistics prices
- At the request of each customer, additional technical equipment is applied to the transport

The aforementioned factors make difference in the price increase percentages for the options in each lane. However, an average overview of the options, price increase, and CO_2 reduction is

provided in the diagram in figure 5.9. The info from "haulier responses" spreadsheet is utilized for the calculation of the average price increases and CO_2 reduction of each option.

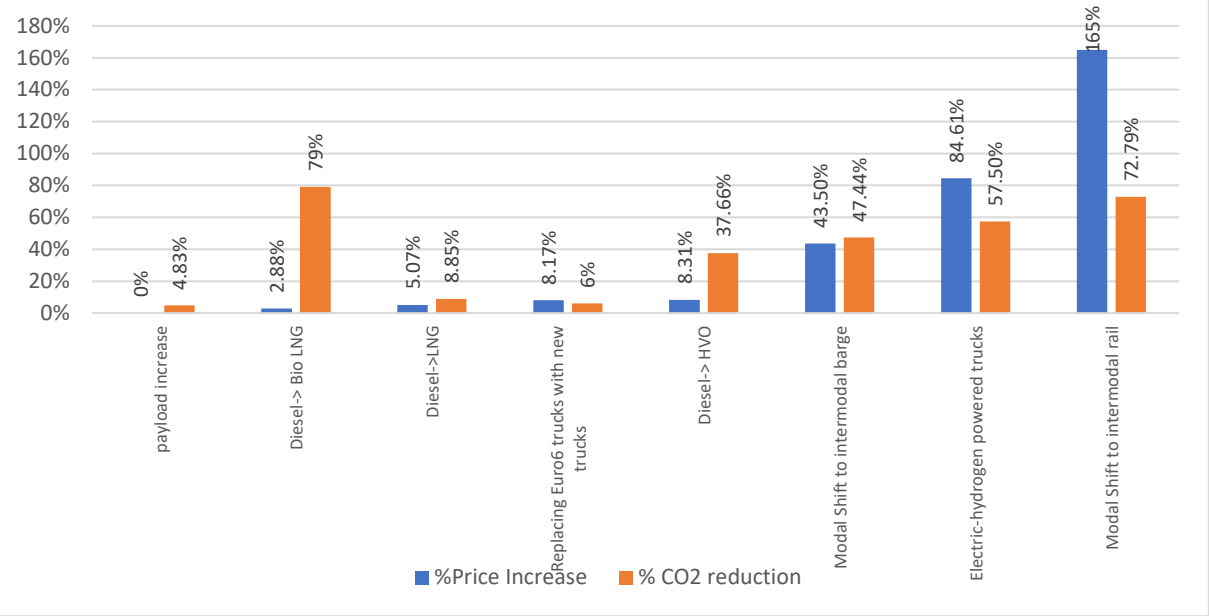


Figure 5.9: Comparison of different sustainability option's effects on price and CO_2 reduction

According to this figure, the first five options of payload increase, fuel change to LNG, Bio-LNG, and HVO, and renewing the trucks are the cheapest options that offer 6% logistics price increase and on average 27.27% CO_2 reduction. Whereas, intermodal options and electric-powered trucks are expensive options that increase the logistics price by more than 43.50% and they reduce the CO_2 footprint by approximately 88.86%. In total, this figure shows 40% emission reduction and 45.36% logistics price increase. Since the customers will be charged for the total price involving maximum of 6% logistics price, the total price increases by 2.27%.

5.5.4 The most polluting lane in 2021

As mentioned in chapter 4 the lanes with the majority of delivery frequencies per year are selected to be investigated in the project because of their great impact on the logistics emission. The number of shipments per year for selected lanes is collected from "haulier responses" spreadsheet. The current CO_2 emission for each lane is collected from the same spreadsheet and the CO_2 emission for each lane per year is calculated by the following formula.

- Number of Shipments per year * emission for a delivery= Total emissions per year.

The result is provided in a diagram in figure 5.10 sorted from the most polluting lane to the least polluting lane. Since the data is collected from the database for the year 2021, the investigation represents the most polluting lane of 2021.

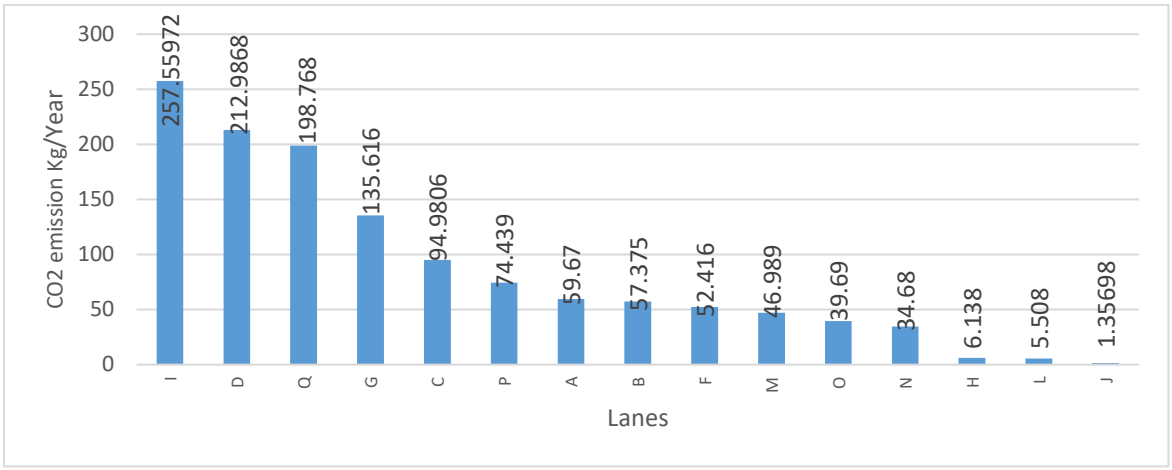


Figure 5.10: Current Emissions per year for different lanes

According to the diagram, lane I is the most polluting lane with emissions of about 257.55972 Kg CO_2 in 2021. The least polluting lane is J with an about 1.35698 Kg CO_2 in 2021.

5.5.6 Emission comparison of lanes with the sustainable options

In figure 5.11 The diagram shows the performance of different hauliers for providing sustainable options. In fact, the emission of the lanes that the hauliers claimed can make the logistics for them sustainable, is calculated from the data in "haulier responses" spreadsheet to find out which lane is the most polluting lane with the options. For this reason, the emission after the option is multiplied by the number of shipments per year and the result is shown in this figure.

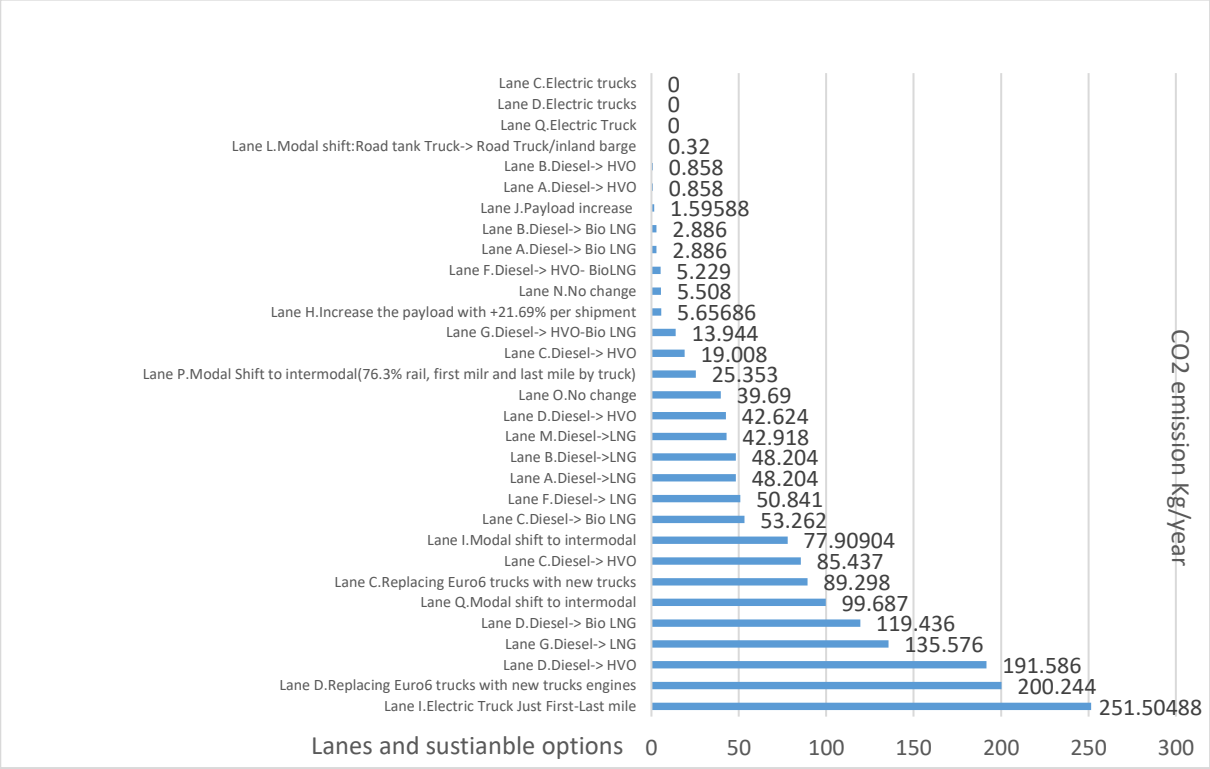


Figure 5.11: Comparison of the lanes emission after the options

According to the figure, lane I remains the most polluting lane by utilizing the electric trucks for the first and last mile delivery. Utilizing electric trucks for the entire lane makes the direct emission zero. It applied to lanes C, D and Q mentioned in the upper first lanes of this figure with zero emission.

5.6 The impact/cost Matrix for the sustainability options

The other applicable analysis of the hauliers' responses is to use the spreadsheet, to make and visualize the Impact-Cost matrix for different sustainability options. This matrix aims to visualize the trade-offs between price increase and the CO_2 reduction percentage. For both elements, the average is calculated to be used for mapping figure 5.9. For the impact, the CO_2 reduction, and for cost the price increase for each sustainability option is considered and the generated matrix is shown in figure 5.12.

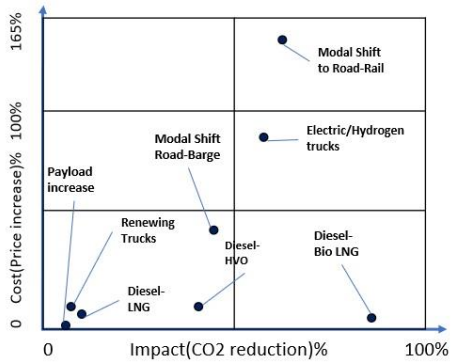


Figure 5.12: Impact-Cost increase matrix for the sustainability options
(Own figure)

As it is obvious from the matrix the modal shift to intermodal has the highest price increase, while the fuel change options for HVO and bio-LNG can provide compatible CO_2 reduction with lower costs.

5.7 Time framework for option execution and certainty of the options

The other information asked from the hauliers and discussed with the Shell staff is the certainty of the options and the time framework for the application of the options. Some of this information is completed in the negotiation with the project's second supervisor and mentor. For both of these factors, the aim of the land logistics team for the execution of this project in September 2022 is considered. Below a short description of these two factors for different options is provided in table 5.3.

Table 5.3: Certainty and time framework for the execution of the option from Sep-Oct 2022

Sustainability option	Certainty of the option	Executable in Sep-Oct 2022
Fuel change HVO, LNG, Bio-LNG	Certain	Yes
Payload increase	Certain	Yes
Renewing trucks	Certain	Yes
Electric trucks	Uncertain	No
Modal shift to Intermodal	Requires long time negotiation to make the option certain	No

5.8 Sub-conclusion

In this chapter, the project sub-activity 2 as the requirement for making the design is fulfilled. This requirement is the info about the sustainability options, certainty about them, and time framework for their execution, and any consequences for the KPIs. This info is obtained from the hauliers via questionnaires and negotiation with Shell staff. The sustainability options are analyzed in the McKinnon framework and the options that the hauliers have provided are part of this framework. According to the analysis of the questionnaires, different options are provided by the hauliers for different representative lanes in the questionnaires. The effect of the option on CO_2 reduction, price, and OTD differ per option that is analyzed in this chapter as well as the factors that affect the offered option and the impact on KPIs. According to the analyses, the fuel change option allocates the

majority and renewing truck the minority of the options to themselves. The analysis shows that the modal shift to the intermodal option increases the logistics price significantly. While utilizing Bio-LNG fuel can reduce the emissions at approximately the same level with lower price increasing. All of the options for all of the representative lanes can reduce the emission of the logistics by approximately 40% and increase the logistics price by 45.36% which results in 2.27% total price increase that the customers pay to Shell.

6 The design of the decision-making business process

In the previous chapter, the requirement for the design as hauliers' input is fulfilled and the hauliers' responses are analyzed profoundly. In this chapter the project sub-activity 3 is fulfilled and the design is generated for sustainability options. The data required for this design is information about the options and affected KPIs. The data collection method and the analysis of received data are provided in the previous chapter. For making the design the hauliers' responses are communicated to the senior sales managers. As the result of the discussions two types of factors are identified, the main and additional factors. The main factors are associated with the option and will be described first in this chapter. Subsequently, some additional factors are described and the combination of them with the main factors determines the applicability of the option and provides the design. The design in this chapter is based on the representative lanes in the hauliers' questionnaires. The design will be first described in words. For this description, the ambition of the land logistics team for project execution in September 2022 is considered. Then the decision-making business process is visualized which shows the design considerations more clearly. At the end of this chapter, a verification table is provided in which the requirements stated in the design elements are checked.

6.1 Communicating the haulier's responses with senior sales managers

In order to make the design, the hauliers responses are discussed with the senior sales manager, senior account manager, product manager and marketing manager, senior sales executive and project, second supervisor and mentor at Shell C&P department. The discussions were open to obtain sales managers' input about the responses and the factor that are required for determining the applicability and acceptability of the sustainability options. The information from the sessions is noted, analyzed, and categorized. Two categories for the info are identified as the requirement for the design, the main factors relative to the sustainability option and additional factors that are not relative to the option but affect the applicability of an option for the customers respectively provided in sub-chapters 6.2 and 6.3.

6.1.2 Design the business process by mind mapping

The design is made based on mind mapping. It is because other factors than the three KPIs in this study are important for the selection of the most appropriate transport option for a customer (Čančer & Mulej, 2006). Shell is not the only party whose desires can determine concepts for the design. Moreover, the prices in the market by other competitors, customer portfolio, and their desires matter. Also, the logistics cannot be considered alone by some customers and also by Shell in some product groups. The desires of the customers are obtained from the discussion with Shell staff that they were not assure about the accuracy of some info from the customer side. So, there exists uncertain data among the info, for each lane, specific factors might be important, the types of options differ per lane and the number of offered options are not equal for all lanes. So, the complexity of the situation made us utilize mind mapping for the design of the decision-making business process which provides flexibility for tackling the aforementioned features for a reliable result (Chang & Ku, 2021).

6.2 Main factors of the design per each sustainability option

Different sustainability options have different requirements and accordingly, they affect the KPIs differently as the consequences. The certainty about the applicability of different options and the feasibility time of each one differs as stated by the hauliers. Therefore, the options are analyzed separately to point out these 4 features for them.

6.2.1 Fuel change

This option is the most common option offered by the hauliers as it is stated in the analysis of the previous chapter. For the HVO fuel, the requirement is nothing but the fuel itself since this fuel can be used in conventional trucks with diesel engines and it can be satisfied by the haulier. However, for LNG and Bio-LNG specific LNG trucks are required but this requirement will be satisfied by the hauliers easily. The consequences of this option for KPIs are logistics price increase and CO_2 reduction. The amount of reduced CO_2 for Bio-LNG is higher than for the other two fuels and LNG has the lowest effect on CO_2 reduction. There is no uncertainty about the use of this option and it can be scaled up fairly soon. Since the land logistics team is willing to execute this project in September 2022, this option is an applicable option to be applied to the lanes toward the customers.

6.2.2 Renewing the trucks

This option has no specific requirement. The haulier would purchase trucks with boosted diesel engines that emit a lower amount of CO_2 by burning diesel fuel. There is no uncertainty about this option and the claiming hauliers are able to scale it up very soon which is aligned with the consideration of the logistics team for this project execution time in the coming months.

6.2.3 Payload increase

This option has some requirements. Firstly the customer has to be equipped with enough large thanks to receiving more product in one time delivery. The second requirement is the legal permission that might not allow for more payload in the customer country. Both of the requirements have to be checked with the customers and in case of the ability for increasing the payload the haulier will load more product towards the customer. The only consequence of this option for the KPIs is that the CO_2 will be reduced slightly. There is no uncertainty about this option and it can be scaled up quickly.

6.2.4 Electric trucks

This option has no specific requirements. However, the CO_2 emission of the transport will be remarkably reduced to zero and the price of the logistics will increase significantly. For this option uncertainty is high since the chemical product transportation by the electric trucks can make a hazard because of the intensity of high voltage in the truck from the HSSE perspective. In addition, since the batteries are heavy the payload will decrease in order not to exceed the limit of the total permitted load which is the sum of the truck weight and load weight. It also makes charging problems for long distances. Utilizing electric trucks is offered only by one of the hauliers in this thesis project with certain numbers of prices and soon scaling up. For the rest 7 hauliers, there is high uncertainty about adding electric trucks in their lanes and it is envisioned as an ambition for the future with a feasible time for the coming years.

6.2.5 Intermodal option

This option has some requirements associated with both intermodal road-barge-road and road-rail-road. The existence of the rail and water channels in the vicinity of the customer location is important. Moreover, the train and barge options sometimes depending on the tanks' sizes and types and the ability of the rail and barge operators for carrying them, do not apply for a low amount of product. So, the customer will be delivered more and they need to be equipped with enough large tanks. The hauliers have to contact the rail and barge operators to provide these options if they do not possess them entailing entering 4PL in the logistics. Although the first and last mile of delivery occurs by trucks, arranging the train and barge takes a long time since the managerial input for the arrangement of such intermodal transport is high as one of the other requirements. The consequence of this option is for all three considered KPIs in this project. The price increase is significant for this option, the arrangement of movements between trucks and rail or barge is a

timekeeping matter that on most occasions leads to delay. So, OTD will be affected negatively despite the significant effect on CO_2 reduction. Delivering with delay to the customer leads to commercial conflict since Shell has to give a discount to the customer and this is not the desire of Shell and the customers (Interviewee P7[31], Personal discussion, July 6, 2022). Late delivery to the customer can affect the production process of the customer and accordingly the customer of the customer. For some customers, OTD is the only factor that has kept the customer to stay supplying from Shell, and making the transport sustainable by intermodal option can make Shell unreliable which is not acceptable for Shell. If the customer is able to place the order earlier then the haulier would be able to deliver on time and have a sustainable delivery without sacrificing OTD. Also, for the short distances, the intermodal option is not an acceptable option for CO_2 footprint reduction when direct transport can deliver the product to the customer more easily. Arrangements of this option to make it a certain option require more time because of negotiations with the haulier, barge, or rail operators and customer that requires a long time, and for the execution of this project in the coming months this option cannot be scaled up soon.

6.3 Important additional factors of the design

In the discussions with the sales managers, project supervisor, and mentor it emerged that there are some other important factors other than the option itself that can determine the acceptability and applicability of the options. These factors are the customers' portfolio in sustainability activities, the price provided by competitors in the market, and the existence of sustainable products besides sustainable transport. A combination of all these factors together with the main factors determines the applicability of the option for the lane and makes the results of the design. Below these factors are described.

6.3.1 Customer portfolio in sustainability

This factor is an important factor that determines whether the customer accepts the option and its consequences. Shell is at the beginning of the supply chain as the supplier of raw material. The price of sustainability has to be paid by all of the parties in the chain. Some tier 1 customers are keen to add any activity regarding sustainability and have a strong portfolio in the CO_2 reduction activities since the tier 2 customers in the chain are also willing to improve sustainability in their portfolio. Therefore, for those customers, the option could be applicable. Nevertheless, if the tier 1 customers are not eager to take a step toward sustainability aims because of the tier 2 customer that does not pay for it, it requires a longer time to negotiate with them and make a plan for the execution and since this project will be implemented in September 2022, for those tier 1 customers of Shell the options can be considered not applicable.

6.3.2 Prices provided by competitors in the market

The existence of different competitors in the market does not allow the price of logistics to grow above a certain level. For different specific products, in one product group, this level differs. So, if the option price consequence is above the critical point for some customers that option could not be applicable. This is the willingness of Shell because it can lead to customer loss when the competitors in the market provide them with lower prices.

6.3.3 Sustainable products besides sustainable transport

From the discussion with the Shell staff, it emerged that the logistics cannot be considered separately from the product. It is not wise to transport non-sustainable products in a sustainable way and vice versa. So, the existence of a sustainable product for the customer is another important additional factor that determines the applicability of an option. This is mainly the desire of customers

[31] Senior Marketing manager in C&P department

and Shell. If the product for that customer can be sustainable then it is likely that the customer accepts the option consequences. For some product groups such as solvents the nature of the product makes it difficult to produce a sustainable product, in this occasion, the logistics can be considered solely without a sustainable product and the other main and additional factors play role in the applicability of the option.

6.4 visualisation of designed decision-making business process

In figure 6.1 the design of the business process is explicitly illustrated. For this map, the main and additional factors obtained from hauliers' responses and senior sales managers' discussions that are in words described previously in this chapter, are required. These considerations must be considered for the options provided for a lane to result in the applicability and acceptability of that option for that specific lane.

- This design of a business process will not change the current method of assigning a transport method to a lane, but it will be added and improve the decisions. As what has been discussed in chapter 4 about the current decision-making system the design will be added to the system in place of the orange arrow pointed out in figure 6.1. This orange arrow is zoomed out on the next page to show where the design will impact the current system. Also, since the historical data that has blocked a haulier for a customer is utilized, the design starts from there by considering and contacting the hauliers for their input for the questionnaires. This entails that the design starts from the last step shown in the decision-making tree. In figure 6.1 this is shown in the right up corner of the figure.

6.5 The way how the design works

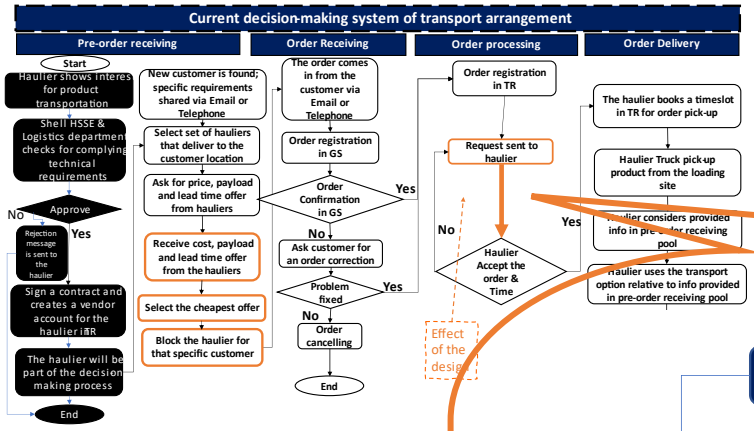
As can be seen in figure 6.1 the design works for each customer in each lane separately. After considering the customer of the lane, one sustainability option must be considered for that lane to follow the decision-making business process in the diagram to come up with the applicability of the option or ending up with utilizing conventional transport methods. Then the other option for that lane must be considered and the steps should be followed as before.

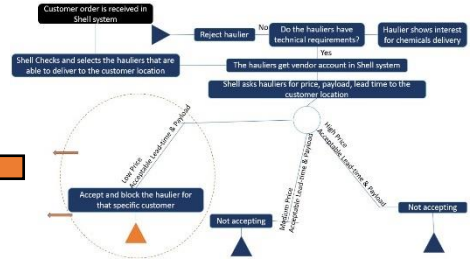
6.6 Additional interpretation from the design

In the design provided in figure 6.1 the execution plan of this project for September 2022 is considered and for the situation that applying the option and arranging its requirements are timekeeping matters, it is suggested to consider conventional transport methods. In addition, since a broader scope of this project will be considered by Shell for the execution, it is suggested to consider negotiations for the situation that result in the "Use conventional transport method". It is an opportunity for Shell to negotiate for a long time and make all of the options happen for the lanes. These negotiations are direct between Shell, customers, and hauliers.

6.7 Verification of the design to stated requirements

To verify that all of the requirements for the design are met, a verification table for the design is drawn in which the requirements for designing the decision-making business process per option are mentioned in addition to the additional factors that are applied to all of the options. The way how the requirement is covered and where it is met in the design is described in this table. A scheme of the verification table for the design is presented in table 6.1.





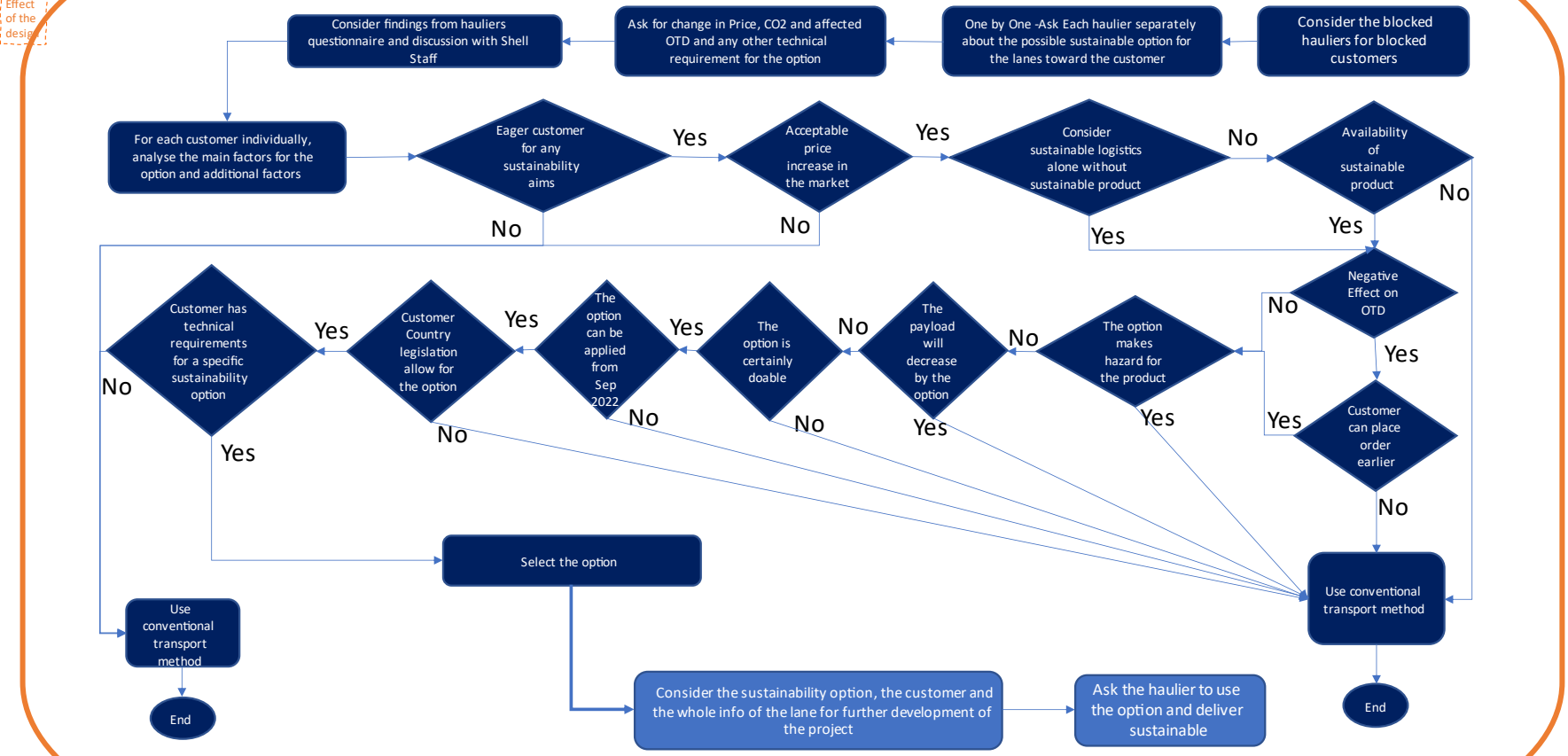


Figure 6.1: Decision-making business process

Table 6.1: Verification table of the design

Sustainability option	Requirement for the design	Requirement is covered as	Place where the requirement is covered in the design
Apply on all options	CO_2 reduction	Fundamental consideration	Rectangle: Ask hauliers for changes in Price, CO_2 and affected OTD and any other technical requirements for the option
	Customer portfolio in sustainability	Additional factors	Diamond: Eager customer for any sustainability aims
	Competitors in the market for the price increase		Diamond: Acceptable price increase in the market
	sustainable product		Diamond: Consider sustainable logistics alone without sustainable product Diamond: Availability of sustainable product
	Certainty	Main factor	Diamond: The option is certainly doable
• Fuel change • Renewing trucks	Price increase	Main factors	Diamond: Acceptable price increase in the market
	Execution time framework		Diamond: The option can be applied from Sep 2022
Payload increase	Enough large tanks	Main factors	Diamond: Customer has technical requirements for a specific sustainability option
	Legal permission for more payload in customer country		Diamond: Customer Country legislation allow for the option
	Execution time framework		Diamond: The option can be applied from Sep 2022
Electric trucks	Price increase	Main factors	Diamond: Acceptable price increase in the market
	Execution time framework		Diamond: The option can be applied from Sep 2022
	Hazard for the product		Diamond: The option makes hazard for the product
	Payload decrease		Diamond: The payload will decrease by the option
Intermodal option	Rail/barge channels in customer vicinity, Enough large tanks, enough long distance	Main factors	Diamond: Customer has technical requirements for a specific sustainability option
	Price increase	Main factors	Diamond: Acceptable price increase in the market
	Long time required for product movement between modals mostly leads to delay		Diamond: Negative Effect on OTD Mitigation Diamond: Customer can place order earlier
	Long time required for negotiation with rail/barge operators, longer time for arranging all managerial input		Diamond: The option can be applied from September 2022

6.8 Sub-conclusion

In this chapter, the project sub-activity 3 is fulfilled. For that, the input from the hauliers for representative lanes is communicated to the senior sales managers and the business process is designed. In the discussions with Shell staff, the requirements, consequences, certainty, and the execution time framework of the options are discussed as the main factors of the options. The other factor separately from the option such as customer portfolio in sustainability, competitors' price in the market, and the existence of sustainable products besides sustainable logistics are identified. All the factors are important for determining the practicality of an option for a customer in a lane and they are separately analyzed in this chapter. At the end of this chapter, all factors are considered for generating a design with all considerations that determine the practicality of an option discussed in this chapter.

7 Design Validation

In the previous chapter, the design main and additional factors are described profoundly. Also, the designed decision-making business process is provided in word and visualized based on the input data from the hauliers and discussion with Shell staff, and the design is verified in the verification table in the former chapter. In this chapter, the design is validated by applying it to a set of customers in representative lanes and project sub-activity 4 is satisfied. Since the hauliers were specifically responding to the questions for representative lanes, the same lanes are utilized to validate the design for them. The way how this validation is conducted is by questionnaires. The info from the hauliers' questionnaires is utilized to generate the validation questionnaires and they are filled by the sales managers responsible for each customer in representative lanes. By the desire of the Shell land logistics team no direct contact with the customers is conducted and the sales managers have presented some info instead of them in the places where this info was required. The generation of the validation questionnaires and the method of how the info is collected are described in this chapter. Moreover, a specific analysis is conducted on the lanes in the questionnaires that will be presented in words in this chapter. At the end of this chapter, the applicable options for execution are presented as the result of applying the design.

7.1 Checking the validation requirements

Since the validation is applied on the lanes to check which options are appropriate to be selected for delivering chemical products, a couple of requirements should be met as follows:

- The first requirement is the lanes. It encompasses the entire info from the lanes such as loading sites, product, haulier name, current transport method, customer country and city destination of that lane. The lanes utilized in the haulier questionnaires are utilized for validation since the info is available for those lanes.
- The second requirements are the sustainability options and their effect on KPIs for each lane. This info has to be collected from the hauliers' questionnaires.
- The third requirements are the Shell and customer considerations for accepting the options by checking the main and additional factors that are all covered in the design. These considerations are the requirement, consequence, certainty, and execution time framework of the options named as "main factors" and the customer portfolio in sustainability, prices in the market by other competitors, and the existence of the sustainable product beside sustainable logistics named as "additional factors". In discussion with the sales managers these requirements will be answered since they are familiar with both Shell and customers' desire. In section 7.1.2 it is more described.
- Comparison of the results from the investigation of the main and additional factors with what the hauliers have provided in their questionnaires.

7.1.1 Importance of customer and Shell desire in validation questionnaires

As what is presented in the design in the previous chapter the customers' desires could be important for the execution of the design on the lanes. As stated by Deloitte[32] insights, sustainability is the concept that can drive new innovative ideas in the relevant area in the case of this thesis project it is in the transport and logistics domain (Capozucca, 2012). Without involving customer desire the impressive technological proofed innovative ideas for CO_2 reduction will not lead to business growth

[32] Internationally professional service network providing risk, tax, financial advisory and consults services globally. *Deloitte | Audit & Assurance, Consulting, Financial Advisory, Risk Advisory, Tax & Legal*. (2022). Deloitte Netherlands. Retrieved 17 August 2022, from https://www2.deloitte.com/nl/nl.html

(Eckert, 2019). Framing this thesis project into this fact embodies the importance of customers' desires since they will be affected significantly by the project implementation in the coming months. It is because the customer will be affected by the option's main factors and they have to bear the trade-offs between the price increase, reduced CO_2 and affected OTD. In case of excluding the customer desire from planning for green logistics, Shell's agreement with the customers, the customer vision towards Shell, and its reputation will be affected negatively.

As stated in the previous chapter in the design, the options have some requirements, and consequences that have to be checked with customers, and Shell's desire also matters for this validation. Shell is not willing to face customer loss and achieving competitive advantage from this project is its desire of Shell. So, for making the design valid and applying it to the lanes the desire of Shell must be captured as well.

7.1.2 Method for obtaining customer and Shell desire

To be able to capture the desire of the customer and Shell for affected KPIs and trade-offs between them the appropriate questions in the validation questionnaires are designed based on the results from the haulier's responses analysis in chapter 5. These questions are specific to each lane and the customer of that lane. The questionnaires are then directly discussed with senior sales managers.

7.1.3 Important matter regarding the collection of the info from the customers

In this project, the customers are directly involved in the validation of decisions. This is requested by the Shell land logistics team not to communicate at this stage of this project directly with the customers. Instead, the sales managers as the voice of the customers who are familiar with their desires are involved to provide both senses about the customer taste and Shell desire in the validation questionnaires.

7.2 Required info for generating the validation questionnaires and questionnaire generation method

To make the validation questionnaires, the analysis of the hauliers' responses is utilized from the "haulier responses" spreadsheet about the options and affected KPIs. The MERMAC model is used for the generation of the structure of the validation questionnaire.

The information from each haulier response is copied as input for the MERMAC model in a separate file to apply the process to them. For each questionnaire, the best method to ask relevant questions is obtained in consulting with the project second supervisors and the mentor with the aim of not impacting sales managers' responses, avoiding bias, utilizing the familiarity of the supervisors with the sales managers' taste for sensing their perspective to generate sensible questionnaires. The questions are generated separately in each customer file and afterward, they are reviewed again to be edited and checked whether they match the question sources which are the hauliers' responses. Then the questions are merged and sequenced in a separate file in a way that directs the mind of the responder in a funnel way which will be described in the next subsection. Then the questionnaires are sorted based on the customer and product. In each product group, the questionnaires are shared with the responsible sales manager for each customer. After recording the questionnaires on the internal system of Shell they are reviewed again by the project supervisor and mentor and tested for validation. The same process for making these questionnaires valid is conducted as what is done for haulier questionnaires explained in chapter 5.

7.2.1 The structure of validation questionnaires

Each questionnaire is started with an introduction to the project and emphasizes the importance of the answers to the questions and information confidentiality. Before starting the first question, the

option and CO_2 reduction of that option are described for the respondents to make them aware of the reason why some KPIs might differ for that representative lane.
Table 7.1 shows briefly the terms asked in the validation questionnaires relevant to the affected KPIs. These terms differ per lane and customer according to the possible sustainability options and different effects on KPIs. A description of the required information is provided below the table.

Table 7.1: Customers' questionnaires terms

No		Required information for the Validation questionnaire
1	Need to know information	Acceptable price increase for % CO_2 reduction
2		The likeliness of acceptance of the option consequences
3		Contractual opportunity
4		Days of ability/willingness for earlier order placement(If applicable)
5		Acceptable price increase for zero-emission electric trucks
6		Any additional comments about the customer, competitors, and sustainable product

1. The sustainability options provided by each haulier are mentioned in the questionnaire and it is requested to provide acceptable cost increasing (%)to each sustainability option in form of open questions. Providing CO_2 reduction by the option assists responders to obtain a more clear overview of the influence of the option.
2. The likeliness of accepting the option and its consequences is asked. For this aim, a Likert scale question is generated. The scales are from 1-9 in which 1 is associated with absolutely not likely and 9 is associated with completely likely. The guidelines for the generation of this scale are obtained from the study of Taherdoost (2019).
3. Acceptance of applying the option on the running contract is asked in form of a closed binary Yes-No question. "Yes" entails an opportunity to apply it to the running contract and "No" entails no possibility of adding the option to the running contract.
4. If the option impacts OTD, it is asked how earlier is the customer able and willing to place the order, asked in form of an open question. Respondents are asked to provide earlier times by days. This question required the customers' response.
5. According to what has been delivered from the hauliers' input, it is expected to involve electric trucks in the fleet to make the logistics zero emission. However, there is severe uncertainty upon them and the acceptable cost increase is asked in case of the possibility of improving this option in the future in the form of an open question. The option of the electric truck is provided from just one of the hauliers as an available sustainability option in the fleet, however, it is treated like the other certain options in the questionnaires and the question is made based on the features of that option.
6. As is discussed in the design chapter the customer portfolio in sustainability, price increase constraint regarding market and competitors play a role in the acceptance of a sustainability option. Also, the existence of sustainable products can affect the result of the design. So, these questions are discussed during the discussion with the sales managers.

7.3 The strategy for framing the content of the questions in the MERMAC model

To make the best out of the MERMAC model the funnel strategy is used for making, editing, sequencing, and sorting the questions in validation questionnaires. The funnel strategy is used to improve the questions' content for obtaining high levels of detailed responses from the respondents. The underlying incentive is to obtain specific numbers for the relevant questions. Moreover, this strategy presents the purposefulness and organized structure of the questionnaire (Grover & Vriens, 2006).

The questionnaire started with an open question regarding the acceptable price increase from the customers' perspective. This open question gives an ease sense to the respondent and it is an incentive to provide details about the acceptable price increase offered by the haulier (Acharya, 2010). The response to this question can be based on the combination of Shell and customer desire. It entails that since the customers are willing not to pay for sustainability the combination of Shell's desire and customer tolerated price provides a good sense of financial applicability of the option. It also pacifies the high-tension question about the price increase. For closed questions in the questionnaire, it is tried to minimize bias associated with the restricted responses by funnel strategy. An overview of this strategy is illustrated in figure 7.1.

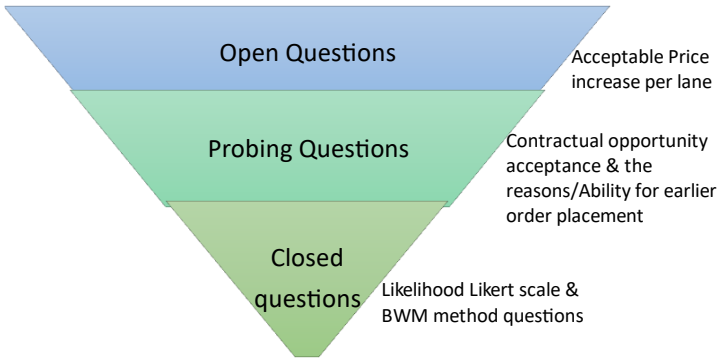


Figure 7.1: Funnel method for generating validation questionnaires (Acharya, 2010)

According to the funnel strategy, the questions gradually become narrowed down from open questions to closed questions. The next set of questions after open questions are probing questions in which it is asked whether the customers are willing to apply it on the running contract in form of a binary Yes-No question and the reason for selecting Yes-No is asked. In fact, in this question, the topic is narrowed down and the application of the option is asked for running contracts with the customer, and an explanation is requested from the respondent. For the customers whose OTD reliability is affected the way to tackle this problem by their ability for earlier order placement is asked.

The last sort of questions are closed questions in form of the Likelihood Likert scale question. It is asked whether the new situation and the consequences for KPIs on scales from 1-9 of absolute not likely to very likely, is acceptable to the customer. This question is asked at the end of the questionnaire to assure that the customer is aware of the logistical sustainability option and all affected KPIs. After filling the questionnaires the "test and questionnaire analysis " from the MERMAC model is applied to them at the end of this chapter it will be profoundly expressed.

7.4 Asked data in customer questions

This questionnaire collects primary data and determines how Shell and the customers value the option and its features and how the changes in the KPIs are acceptable for them to measure the applicability of the sustainability option.

7.5 Data collection method for validation questionnaires

Since the data collection method impacts the response rate, because of the nature of the questions that need discussion and for some sales managers to convince them regarding the project's importance, the questionnaires are sent to them via email firstly, a brief summary of the project is provided and afterward, in scheduled meetings, the idea is discussed directly and the questions are filled in an online or in-person meeting in the office and any other managerial input are noted.

7.6 Considerations in the discussions with the sales managers

In the meetings with the sales managers, the share of the logistics price from the total price is asked for each product group. As stated by interviewee P8[33], interviewee P9,[34] and interviewee P10[35] for all of the products in this project this share is 2-6% of the total. This is because the products value is high so the product margins are high and the logistics price is not significant compared to the product price (Personal discussion, April25-28, 2022). This matter is considered in the discussion with the sales manager for filling out the questionnaires. However, an in-depth investigation of them is provided in chapter 8 to ease the conversation with other teams in the C&P department and customers.

7.6.1 Low response rate prevention and data collection method

To prevent delays in receiving the responses to the validation questionnaires, inviting language is utilized for asking the questions. For that, the benefit of the project for the customers is presented and the importance of the questionnaires is emphasized. Also, the structure of open questions for pricing and likelihood question is simplified to make the questions understandable. Also, the funnel strategy inside the utility criterion of the MERMAC model, restricting the number of questions to 6-7 depending on different levels of KPIs has a direct effect on the reduction of the low response rate.

7.7 Validation questionnaire analysis

In this section, the validation questionnaires that are filed in the brainstorming discussion sessions with the sales managers are analyzed in detail. The discussion results are then compared with the hauliers responses to obtain an outcome from the validation that shows the lanes and applicable sustainable transport option for that lane and the customer in that lane.

7.7.1 How validation questionnaire analysis looks like

The responses to validation questionnaires are investigated separately for each customer and their lanes since the desires of each customer is specific that cannot be compared to other customer and the replies to the questionnaires are not equal in term of the availability of the answers and the types of answers. Some of them have no answer and some of them are filled certainly and some others are just guesses because of not possess of dominant familiarity of the sales manager with the customers' desire and equipment. Also, each sustainability option has its own requirements that have to be fit for the specific customer.

7.7.2 Products involved in the validation questionnaires

The logistics of products from PODer, Solvent, HOder, Heavy olefins and styrene were involved in this project for the hauliers' questionnaires. However, due to a lack of consensus about the importance of sustainable logistics the information on logistics of products in the PODer, Heavy Olefins, some Solvent products, and Styrene group was obtained.

7.7.3 Interpretation per customer in each product group

The validation of the design via validation questionnaires provides a suggestion to the land logistics team on the practicality of different options for the customers in representative lanes in the further development of this project. For each customer in each product group, an explanation is provided based on the input from sales managers and the relevant terms of the design that applies on each lane and comparison with the hauliers' offer. This explanation shows how the design is applied to

[33] Senior sales manager
[34] Product manager and Marketing manager
[35] Senior Sales executive

each lane. Since the validation questionnaires are filled by the sales managers of each product group, their explanations are provided per product. The required information for this interpretation is from hauliers' questionnaires, design, and all managerial input from sales managers responsible for each customer in Shell while filling these questionnaires.

Styrene:

1. Lane D

For this product group, there is just one lane in the analysis. This lane is important as stated in figure 5.10 as the second polluting lane.

Haulier B has offered two sustainability options for this lane that impact the price KPI. For this lane, the acceptable price by the customer fits in the range provided by the haulier for both renewing the truck option and changing the fuel option. For renewing the trucks the price provided by the haulier is 10.45% which is slightly larger than what the customer will accept at a maximum of 10%. However, it is negotiable since the difference is not remarkable. The customer in this lane will slightly accept the financial consequence of the truck renewing option since its impact on CO_2 reduction is relatively low at about 6%. The price provided by the haulier for fuel changing to Bio-LNG is 14.87%-25.18% and the customer acceptable price increase is 40%. It entails that the customer will accept the price increase resulting from this option and it will be more acceptable than renewing trucks because of the higher impact on the CO_2 emission reduction at about 20-90% and it is likely that they accept the price consequence of this option.

The prices as mentioned earlier are acceptable for this customer so they will accept both options. However, for none of the options, there will be a possibility to apply them on the customer running contracts and the negotiations have to be accomplished from the next contract for option application on this lane. Using electric trucks is not an option provided by the haulier of this lane. Nevertheless, in case of the possibility of using electric trucks in the future, the land logistics of the C&P department has to consider the maximum acceptable logistics price increase of 40% for the customer. According to the managerial input, This company is a new company that considers any sustainability goals and the negotiation is open to them regarding low emission logistics.

PODer:

1. Lane G

This lane is the fourth polluting lane as stated in figure 5.10. The acceptable price for fuel change to the LNG option is zero since the effect on CO_2 reduction is very small at about 3% and the customer of this lane is not willing to pay any for a very small change on emission reduction and this option is absolutely not acceptable for this customer and it is willing to achieve high for what it pays. The other sustainability option is fuel change to HVO that involves the price increase of 0.69% with up to 90% CO_2 reduction and the customer will welcome this option that affects CO_2 emission significantly but only in the condition of the combination of this sustainable transport with sustainable product to be transported in that lane. As stated in the managerial input there is a possibility to generate sustainable products for the customer of this lane. Therefore, the customer will accept a 100% logistics price increase for a combination of sustainable products and logistics. This customer is eager to apply this sustainability option on their current running contract with absolutely acceptable likelihood. As stated in the managerial input the tier 2 customer, a big company in automotive industry is asking for making its whole supply chain 20% sustainable by 2030 and Shell's tier 1 customer is supplying them 100%. This is the reason why the customer is keen to apply sustainability in both product and logistics areas together. In the case of utilizing electric trucks, the customer is willing to pay 100% extra logistics price just in combination with a sustainable product.

2. Lane Q

For this lane, the option of modal change from direct road to intermodal road-barge-road affects all of the considered KPIs in this study. As stated by haulier H the logistics price will increase 43.50% while the maximum acceptable price increase is 25%. This percentage is the maximum price increase that Shell allows for logistics costs because of the competitiveness of the market just in condition of not affecting OTD. Any logistics price increase above mentioned percentage will lead to customer loss that is not in favor of Shell. However, it is not likely that the customer of this lane accepts this option because of the managerial input revealed by the sales manager:

- The customers are willing to pay less and gain more. It entails that regardless of the 43.56% extra cost since the logistics emission share from total emissions in the EU is 25% it does not worth it from this customer's perspective (European Commission transport emission, 2019; IPPC, 2018).
- Also, this option requires a lot of managerial effort since the barge operators need to be included, it will be less flexible. Regularly, direct road transport method is used for this lane that takes 1 day, this option requires 5 days earlier order placement since
    - ♦ Only specific times per week the barge operators operate for transporting products.
- North sea storms can affect the OTD negatively and result in delays and minus points for the reliability of Shell which is not acceptable by Shell nor by the customer in this lane.
- This is a short lane and this option is not appropriate for this lane when the direct road option can be utilized and takes just 1 day for delivery.
- Due to high movements between different transport modes the risk increases and accordingly it requires substantial control and observation during the movements (Interviewee P6, personal conversation, April 20, 2022).
- This option requires long time negotiation and arrangements (Aronsson & Huge Brodin, 2006).

According to the customer in this lane, only 4 days before the delivery date is the earliest time that an order can be placed. This is a short time for arranging intermodal transport and the haulier requires at least 5 days to arrange the transport and deliver the product on time. Therefore, although this option can reduce about 60% of the emissions, it is not applicable.

The other option provided by haulier H is utilizing electric trucks instead of diesel trucks for the entire lane. This option is an expensive one with an 84.61% price increase whereas the maximum price increase is 25% because of the existence of competitors in the market for this lane. Also, according to the familiarity of the sales manager with the customer, it will not pay more than 25% extra for the logistics. Therefore, it is absolutely unlikely that the customer accepts the price increase as the affected KPI by this option although this option will reduce transport emissions to zero. If the price could be negotiable to come up with lower costs, it is possible to apply it to the current contract in the condition of combination with the sustainable product and a certain safety regarding the uncertainty of the electric trucks.

3. Lane H

This lane is already sustainable by intermodal transport of road-rail-road and the only provided option by haulier D for this lane is the payload increase that does not affect price and OTD and the effect on the CO_2 reduction is very low at about 7.15%. It is absolutely not likely that the customer accepts this option since the customer has no capacity for receiving more product per delivery because of possessing small tanks. The managerial input reveals that the customer of this lane is not eager to increase the sustainability level of the logistics in this lane since any additional prices because of adding sustainability cannot be paid by the other parties in the chain and tier 2 of the customers in this lane are not ready for accepting higher prices.

4. Lane E

This lane is already sustainable by road-rail-road transport method. The first option provided by haulier B for this lane is utilizing bigger containers. In other words, the payload will increase by this option and the effect on CO_2 reduction is very low. The logistics price and OTD will remain the same. However, due to not possessing enough capacity in storage tanks it is absolutely not likely that the customer accepts this option. The other option is utilizing electric trucks for the first and last mile delivery which can reduce CO_2 emissions to 15%. However, this option is absolutely not likely to be acceptable to the customer in this lane because of the disadvantages of utilizing electric trucks because of the high uncertainty mentioned in chapter 5. From the managerial input, it is concluded that since this lane is already sustainable by intermodal transport, no additional changes for improving the sustainability are acceptable to the customer and this lane encounters high delays related to the intermodal transport method.

5. Lane L

The option provided by haulier D for this lane is switching from direct road to intermodal road-rail-road. Although the price increase is not announced by haulier D responsible for this lane, the intermodal option is absolutely not acceptable to the customer in this lane because of the negatively affected OTD. Also, according to Shell's desire this option is not acceptable for this lane. Normally 2 days in advance the customer places the order and they can't place the order 5 days earlier than the requested delivery time -required time to deliver on time- due to product constraints and uncertainty for this lane. As managerial input reveals, this customer will not pay for logistics emission reduction solely. It needs to be combined with sustainable products. Although emissions for this lane could be significantly decreased by this option up to 35.88%, it is not practical.

Haulier F is the other haulier that delivers another product in the PODer group to this customer. The haulier utilizes already sustainable intermodal road-rail-road transport for this lane and there is no other option for making it more sustainable. In the case in the future there will be a possibility of utilizing electric trucks it will not be acceptable to the customer without receiving the sustainable product besides sustainable transport and they will not pay for sustainable logistics solely.

Heavy Olefins

Lane I

Two options are provided by Haulier D for this lane. The first one is increasing the payload. The customer of this lane is moderately likely to explore this option for this lane since the price and the OTD will not be affected and from the customer perspective in this lane, the small effect of this option on the CO_2 at 2.35% is valuable. This customer has big tanks and fulfills the requirement for applying this option on the running contract only in the condition that local regulations of Germany as the customer location allow for the maximum payload. This matter has to be checked with the customer. The other option is to shift from direct road to intermodal road-rail-road. Although CO_2 will be reduced by 69.75% by this option the OTD will be negatively affected and the price will be significantly increased by 300%. From the managerial input, this customer is not ready to pay for sustainability since the subsequent tier 2 customers in the chain are not ready for taking the financial burden of it. So, it is absolutely unlikely that the customer accepts this option. In the managerial input, it is expressed that this product is a hazardous product, and the shift to intermodal increases the risks and from HSSE point of view it will not be acceptable to Shell. As stated by the sales manager there is high uncertainty about utilizing electric trucks for chemical transportation. However, the maximum acceptable price increase for using them will be 10%.

Solvents

For this product group, there are 5 customers and 6 lanes and each lane to a customer is analyzed separately.

1. Lane O

For this lane, no option is provided by haulier F. This lane is already sustainable by utilizing intermodal road-rail-road and in the case in the future, there will be a possibility for utilizing electric trucks it will be accepted for customer in this lane and this customer will accept a maximum 20% logistics price increase. However, it is not possible to utilize electric trucks in the near future since due to regulation of the loading sites no electric truck is allowed to enter there and maybe for the future the regulation change and this option become more certain to be utilized.

This customer is facing severe delays because of the intermodal transport already applied on the lane and in terms of OTD there is dissatisfaction.

2. Lane C

Unfortunately, the responsible sales manager had no idea about any perspective of the customer regarding any questions in the validation questionnaire. Nevertheless, as stated on the customer company website they take sustainability aims as one of their strategic targets earnestly. Also, they aim to enable sustainability in their own customers (Tesa Company, 2021). Therefore, they are considering the ambition of sustainability of the whole supply chain for 2022. For this lane, two options are provided by haulier B. The first one is renewing trucks in the fleet by which the diesel engines reduce 6% less CO_2 emission and the second one is changing fuel to HVO and Bio-LNG which affects the emission significantly at about 20-90% reduction. Both of the options increase the price between 5.90-13.71% which probably will be acceptable for the customer and can be considered as the starting point for further development of this project.

3. Lane A & B

The provided option by haulier A for both of the locations of one customer in these lanes is changing the fuel to HVO, LNG, and Bio-LNG which will decrease the emissions by 90% for HVO and Bio-LNG and by 15% for LNG that will be welcomed by the customer. It is slightly likely that this customer accepts this option and there is a possibility to apply it to the current contracts. The maximum acceptable price increase for the logistics is 7% for the customer and according to what haulier A has provided the price will increase a maximum of 5%. Therefore, all of the sustainable logistics options are applicable for both of mentioned lanes in combination with sustainable products.

4. Lane P

The haulier G of this lane has provided the option of modal shift from direct road to intermodal road-rail-road. The customer in this lane will not accept and pay for this option since OTD will be negatively affected. Thus, it is not likely that the customer accepts the option. As stated by the sales manager, the intermodal way of transportation is uncertain since it requires a long time of negotiation and leads to remarkable delay in product delivery despite reducing 61.30% of the emissions. For this customer, the only factor that encourages the customer in this lane to supply its raw material from Shell is the reliability of Shell in delivering on time. This customer will not place the order earlier. Therefore, this option does not apply to this customer. If it is possible in the future for utilising electric trucks due to high uncertainty about them it will not be acceptable to the customer in this lane.

5. Lane J

The only option provided by haulier D is the payload increase for this lane. The customer of this lane is eager to apply this option on the running contracts since the price and OTD will not be affected by

this option. One of the requirements for this option application is the bigger storage tanks of the customer since the product amount per delivery will increase. The customer is equipped with bigger tanks and it is able to receive more products per delivery. Currently, they are being delivered at 22 metric tonnes which can be increased to 25 metric tonnes per delivery by the load limitations of Germany. In case of the ability for providing electric trucks in the future the maximum price increase for the logistics will be 5%. This lane is an applicable lane for the further development of this project.

7.7.4 Result of applying design on the lanes

Lastly, table 7.2 provides a complete overview of the customers and the lanes that sustainability options are applicable for them and further project development and execution is according to this list.

Table 7.2: Result of the decision business process application on lanes (Design validation)

Lanes	Haulier of the lane	Regular transport method	Doable Sustainable transport option	Special requirement
Lane A	A	Direct Road	Diesel->HVO Diesel->Bio-LNG Diesel->LNG	Application on running contract only in combination with sustainable product
Lane B	A	Direct Road	Diesel->HVO Diesel->Bio-LNG Diesel->LNG	
Lane G	C	Direct Road	Diesel->HVO	Application on running contract only in condition with sustainable product
Lane D	B	Direct Road	Diesel->Bio-LNG Renewing trucks	Application on new contract
Lane I	D	Direct road	Payload increase	-
Lane J	D	Direct road	Payload increase	-
Lane C	B	Direct road	Renewing Trucks Diesel->HVO Diesel->Bio-LNG Diesel->LNG	-

Since this project encompasses a small scope of the Shell chemicals transport activity, the result of the design application and validation shows a restricted number of lanes that the options are applicable for them.

7.8 Sustainability options success chance likelihood

The validation questionnaires are analyzed based on the combination of sustainable options' main and additional factors defined previously in this chapter. Subsequently, the reasons why sustainability can be improved in their lanes are described as a combination of mentioned factors. In this section, the number of lanes that have voted for different levels of the likelihood of accepting the sustainability option is provided. The required data for the interpretation is collected from the Likert scale question of the validation questionnaires and shown in figure 7.2. Some guidelines for this interpretation is obtained from the study of Taherdoost (2019) in his study about designing response scale for the questionnaires.

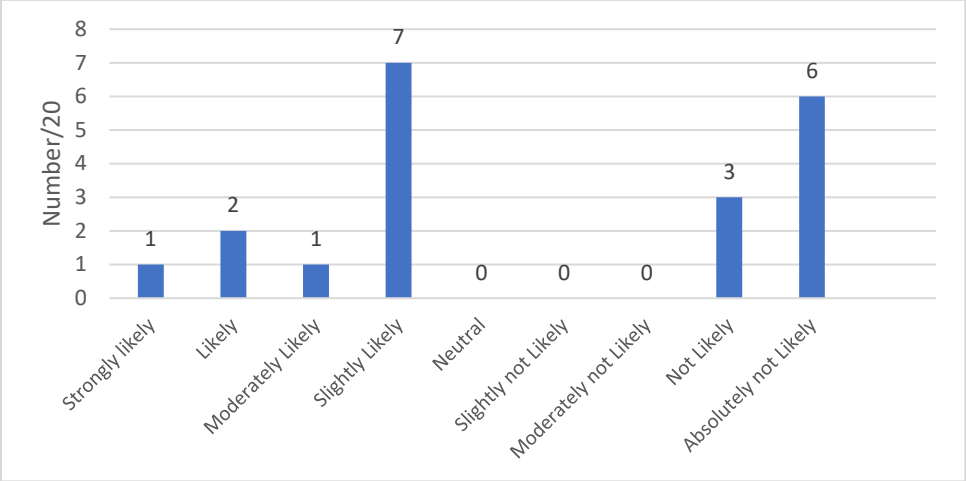


Figure 7.2: The likelihood of acceptance of the sustainability options for 20 options at different levels

According to the diagram, from 20 sustainable options in total for 14 lanes and 12 customers involved in the questionnaires, 11 options are accepted more than slightly likely and 9 of the options are not accepted to be applied on their relevant lane. The lanes with the likelihood above "Neutral" will be applicable lanes that the sustainability option offer can be applied on those lanes which are provided in the next section.

7.9 Options acceptance rate

In this section, the likelihood rates from the validation questionnaires are utilized to determine for which hauliers and options provided by them the likelihood is rated more than "Neutral". Figure 7.3 shows this fact.

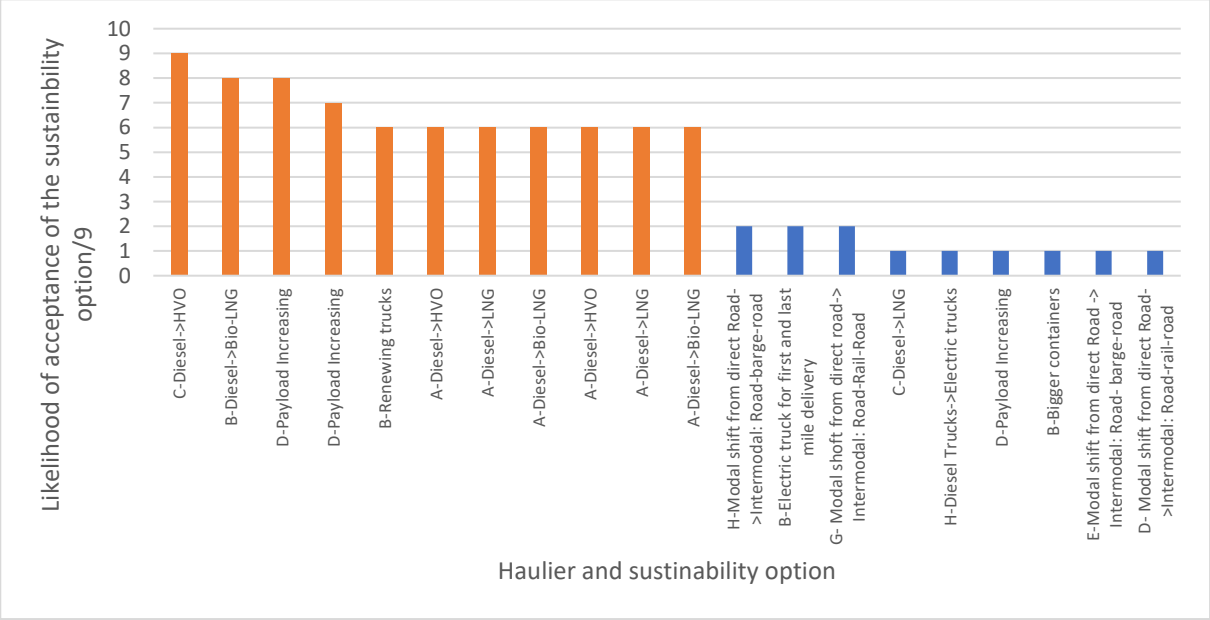


Figure 7.3: The likelihood of acceptance of the sustainability options provided by different hauliers

The options of the modal shift from direct road to intermodal road-rail-road and road-barge-road and electric trucks are not likely and absolutely not likely to be accepted by the customers. Hauliers A, B, C, and D are providing fuel change, payload increase, and renewing trucks that are more than "Neutral" likely to be accepted by the customers and the further development of this project could be started with these hauliers. This is shown in orange columns in the figure.

This result is scientifically mentioned by Blauwens et al (2006) that significant acceptance is for altering the fuel to more sustainable types as mentioned above. It is because the initial price for making the logistics sustainable by changing fuel is less than the transport mode shifting to intermodal. Also, management of the product transporting by adding another logistics mode such as train or barge requires more attention concerning product safety and risks. How more the movement points, how more the risks standing for chemical transportation (Blauwens et al., 2006). This is the reason why the modal shift from direct to intermodal is not acceptable and the tendency is more for fuel change options.

7.10 Findings from the result of design validation

According to what is discussed with the Shell sales and marketing managers, what is provided about the design validation and the lanes for which the sustainable logistics option is applicable, it can be concluded that the sustainable logistics concept is still immature among different companies in the chain. Maybe the reason is that the logistics emission contribution to total emission is ¼ at about 25% of total CO_2 emissions. They are not willing to pay much for it and the main focus is on the sustainable product than on sustainable logistics. This has affected the main focus of the internal staff of Shell in other teams than the logistics teams in the C&P department and this has resulted in disagreement about the importance of sustainable logistics in the department.

7.11 Contribution of the design from total emission

According to table 7.2, the payload increase, fuel change and renewing trucks options are applicable to be applied on the lanes. All these calculations are generated from figure 5.9. At a glance at figure 5.9 it emerges that these options can reduce the emission by an average of 27.27%. Table 7.2 shows the lanes with the current transport method of direct road that can become sustainable. From 14 lanes in the validation questionnaires 10 lanes had direct road transport and 7 out of these 10 lanes can become sustainable. Thus for 70% of the lanes with the direct road transport method the three aforementioned options with an average emission reduction of 27.27% can be used that in total will lead to 19% emission reduction for direct road transport.

Since the lanes in this project are selected to be representative of the other lanes in the outbound logistics portfolio, if the design was resulting in the applicability of all of the options of fuel change, payload increase, renewing trucks, electric trucks and internodal options for all of 14 lanes provided in “haulier responses” spreadsheet, the emission of the logistics could decrease in average by approximately 40%. Nevertheless, only 7 out of 14 lanes can become sustainable entailing 50% of the lanes. It results in 13.60% of the total emission containing the current method of transport of direct road and intermodal. The required information for these calculations is from figure 5.9.

7.12 How to use the design and generalise it for other lanes

For the execution of this project, the lanes provided in table 7.2 can be executed immediately in September 2022. Since the land logistics team is willing to expand the domain of this project and make the logistics of more lanes sustainable to reach its goal of 50% emission reduction by 2025, it is suggested to consider the transport methods of payload increase, fuel change option. The renewing trucks option is an option that the hauliers do whenever they feel the trucks have to be renewed and Shell cannot dictate it to them or ask it from them. Nevertheless, the other two options can be asked from the hauliers and the fuel change option is more effective than the payload increase. For new lanes these options have to be checked for their effect on the KPIs and whether they can be used for the entire lane or the first and last mile delivery. Then, the discussion with the sales manager responsible for each customer has to be conducted to obtain the taste of the customers and better

planning for negotiations with them. The rest of the process of execution will be the same as what is provided in chapter 9 for the execution of this project.

7.13 Sub-conclusion

In this chapter, the project sub-activity 4 is fulfilled. For that, the design is applied to the representative lanes that were in the hauliers' questionnaires to investigate the applicability of an option for a customer measured in validation questionnaires. For each lane, a specific questionnaire is generated that encompasses the relevant terms such as price increasing, contractual opportunity, the likelihood of accepting the option by the customer, etc presented in this chapter. Sales managers responsible for each customer are asked to directly discuss the questionnaires. For this investigation, the goal of the land logistics team for the execution of this project in September 2022 is considered and the results of the discussion are compared with the responses of the hauliers for an accurate comparison. The result of the validation and application of the design on the lanes is provided in table 7.2. Fuel change, payload increase, and renewing truck options are applicable to be applied on the relevant lanes immediately in September 2022.

8 General analysis and implementation plan of this project

In the previous chapter, the design is validated via the validation questionnaires in which the design is applied to representative lanes and a profound evaluation is dedicated to them. The result of applying the design to lanes is provided in table 7.2 which shows the lanes that immediately after this project can become sustainable. In this chapter the project sub-activity 5 is satisfied in which some general analysis on stakeholders, changes in the contract terms, the growth strategy and market effect, and SWOT analysis are conducted. Also, the strategic evaluation of this project is presented to measure the strategic outcome of this project. Furthermore, the stakeholder analysis is utilized to propose an implementation plan with the engagement of the primary stakeholders at Shell to fulfill the project sub-activity 6. Also, the framework an action is provided to ease the negotiation with the customers.

8.1 How the agreement with the hauliers and customers will be affected

In the previous chapter, the sustainable logistics options of fuel change, payload increase, and renewing trucks are mentioned to have high acceptability chance to be applied on the relevant lanes. The hauliers will be responsible to provide sustainable delivery to the lanes provided in the result of the validation questionnaires. The customers will also be affected since they need to pay for the option and they are affected by the consequences of the options. However, the agreements with hauliers and customers will be affected differently.

8.1.1 Changes in Haulier contracts

Since the suggestion for the land logistics team is to take the fuel change options from diesel to LNG, Bio-LNG, and HVO, payload increasing, and renewing trucks into account for the starting point of this project, the only KPI that will be changed is the price. Therefore, it is not accounted for a requirement of a new agreement generation with the hauliers and a side agreement will suffice in which the prices will be modified to the new situation. The agreements of the hauliers are for 3-5 years which will not be changed.

8.1.2 Changes in the Customer contracts

For the customers that are willing and accepting the option to be applied to the running contract, an invoice will be made and they are expected to pay more for the sustainable logistics. This is because the options as the result of the design validation only affect the price and the customers can be charged more via invoice for sustainable delivery. Nevertheless, the new sustainable delivery method must be negotiated with the customer and the customers must be aware of the reason for the price increase. Also, they must be guaranteed green delivery and this item will be more discussed in the implementation plan proposal in the next chapter.

For the customers that are willing to be delivered sustainably from new contracts, some of the terms of the new contract will be changed as follows.

Since the contracts with the customers are classified in the high confidential documents there is no access to the contracts directly. Nevertheless, the offer book[36] from the chemicals department is utilized to investigate the terms that will be changed by this thesis project in the customer contracts as shown in table 8.1. The majority of the terms in the contract belong to the product and its

[36] Internal confidential document of Shell providing Shell chemicals offers to the customers for different product lines trading in all continents

specifications. A brief description of the terms and potential terms to be altered by this project execution is provided in this figure.

Table 8.1: Changes in the customer contract terms

No	**Contract Term**	**Affected terms by the design**
1	Exceptional reliability	×
2	Exceptional flexibility	×
3	Financial	×
4	Customer service	
5	Product line specific offers	
6	Complementary services	

1. Exceptional reliability: This term defines logistics-related matters such as supply security and on-time delivery commitment. The practical suggested options that are the result of design validation do not affect the safety and security of the load. So, this term will not be changed in the new contracts. However, the sustainable transport method has to be mentioned here in this term.

2. Exceptional flexibility: This term defined the flexible delivery location, order flexibility that can be a rush order or regular order that is not relevant to this project domain as well as order quantity flexibility. The last is stated as the “full load” for all 4 types of products in the customers’ contracts in the entire Europe. It entails that if the transport mode would be able to load more, the only required thing is to check it in a connection with the customer for their extra storage capacity and legal points of the customer location and the extra product will be loaded on the transport mode. It will induce financial consequences for the product and no change will be applied to the logistics price. This is the effect of the payload increase option.

3. Financial: This term contains the sub-term risk exposures of the supply chain which is defined in the CPT terms for all product lines of execution plan resulting from design validation. By applying this project no change in this sub-term will be applied. The payment term is the other sub-term that will not be affected by the options. Since the payment for logistics is not separated from the product the logistics pricing will also be paid by the payment for the product. The payment terms will not be affected by this project and the customers will be charged at the same moment as the current time. The logistics prices need to be modified as a consequence of adding sustainability options. For sustainable transport, the logistics prices will be modified here in this section. Nevertheless, the payment terms will not be changed and just invoice prices will be increased.

4. Customer service: This term defined the focal point to be in contact with the customers which will be the logistics department of Shell chemicals. This term will not be changed after the project execution and this department will remain the responsible party for the contact with the customers.

5. Product line specific offers: This term specific offers relevant to the product such as free sample of the product, product market assessment and product quality specifications, and manufacturing reliability. These sub-terms are all relevant to the product and there will be no change regarding the logistics specifications and this project implementation.

6. Complementary services: This term defines the safety walks, technical support, and customer events for more engagement with the customers to support and involve them in the development of the product line. This project implementation will not affect this contract term since this support is focused on the product.

8.2 Stakeholder analysis

Since Shell is a big and international company the activities scope of the land logistics team from the HSSE & Logistics department will affect the department's activity and several internal and external parties named as the stakeholders. This analysis aims to investigate how the stakeholder's characteristics will impact the decision-making process and how they will be involved in this project (Brugha, 2000). The stakeholder analysis can assist in the prediction and management of future actions and mapping the effective stakeholder engagement strategy for obtaining a strategic outcome for this project. This stakeholder analysis is required for proposing an implementation plan at the end of this chapter.

The stakeholders are analyzed by their interest and engagement in this project provided in the stakeholder table, the stakeholder relationship map and afterward, the interest-influence grid will be provided for the identified stakeholders classes.

8.2.1 Stakeholders relationship mapping methodology

In this project, several stakeholders are identified as entities and the relationship between them is an important matter that can drive the project to the correct stakeholder management. The model used for this analysis is the model developed in 1984 by Freeman and the digital version of the book from 2010 is utilized for this analysis (Freeman, 2010). As stated by this model, the main firm as the project owner is placed at the center surrounded by different stakeholders. A scheme of this model is shown in figure 8.1.

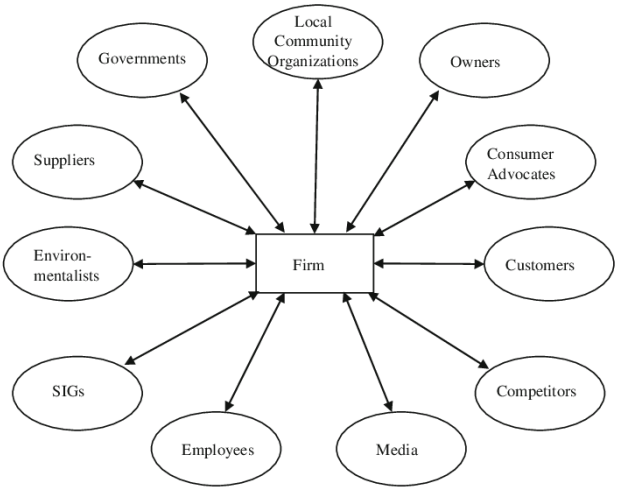


Figure 8.1: Freeman model for stakeholder analysis
(Mishra & Mishra, 2013)

8.2.2 Stakeholders relationship analysis as a requirement for utilizing Freemen methodology

To be able to use the Freeman model to conduct the stakeholder analysis, guidelines from the study of Rześny-Cieplińska et al (2021) are used to identify and classify the stakeholders. For this aim, the parties that are affected by or impact the strategies generated in this project and the parties that have an interest in the project are identified and listed.

8.2.3 Utilised information for mapping stakeholders

To be more accurate about all stakeholders, several meetings with Shell staff have been conducted. The people who were involved in the discussions regarding the stakeholders are interviewee P11,

interviewee P1, Interviewee P2, interviewee P12[37], and interviewee P13[38] as well as the managerial input from the sales managers and the total discussions during the entire internship period.

Also, the input from hauliers questionnaires and the sales managers' input in the validation questionnaires is considered to make the table as complete as possible. In this regard, the discussion notes with the marketing, finance, and supply planners are utilized as well as utilizing a set of literature that will be mentioned in the description of the table. The relationship network is mapped based on practical perspectives. It entails that the results from the decision support for practical sustainability options are captured to map the table. For instance, some stakeholders relative to electric vehicles or intermodal transport options would not be involved.

Considering all relevant stakeholders is a complex matter that involves many parties that can be small teams in the departments of Shell or companies outside Shell, known as a no-straight forward matter (Gammelgaard et al., 2017). However, it is tried to make the table as complete as possible for this project.

8.2.4 Stakeholders classification

Prior to mapping the stakeholders with respect to this project, it is beneficial to provide a classification for different stakeholders. It is because the number of the identified stakeholders is significant and classification can assist in better understanding of their role (Walker et al., 2008). The analysis can visualize the complexity of the relationship and network between all stakeholders in this project.

The review of some external parties is specifically collected from a case study accomplished by Rześny-Cieplińska & Szmelter-Jarosz (2021) in Poland. This study is a sustainability project in the domain of logistics in an EU country, therefore the results would be relevant to this project's domain and some common points can be used for stakeholder analysis. Also, the study conducted by Bellos et al (2021) about the general perspective of stakeholder network of LNG bunkering facility is utilized for the classification guidance.

There are different ways by which the stakeholders can be distinguished.

- The first way is to classify them by their inclusiveness as part of Shell known as internal or external. This classification makes the plan for the management of the stakeholders structured and assists to distinguish the responsibility of the focal firm (Shell) towards them or vice versa (Brugha, 2000). Also, as another distinguishing point, the internal matters of the company are known by internal stakeholders whereas it is unknown to the external parties (Bellos et al., 2021). According to Zenezini et al (2017), the stakeholders can be distinguished based on their role and interests in the project.
- The second way is to prioritize them based on their involvement at different stages of further development of this project. The stakeholders that need to be involved at the beginning of the further development and execution of this project are named primary stakeholders. Secondary stakeholders are the other parties and departments that will be added at the later stages of the project execution.
- Critical stakeholders are the stakeholders that the further development and execution of this project depend on them. They can hinder the development of this project and in the case of no cooperation, further development can be stopped. Shell land logistics and customers are the first critical stakeholders that can hinder the project execution at later stages. If the competitors in the market provide better sustainability options for the logistics with more

[37] IDT(Information and digital technology) Advisor Supply Chain & Logistics
[38] Result Driven Change manager, Project & Technology, Information & digital Technology.

effect on the CO_2 reduction at a lower price, this project development will be hindered. The sustainable fuel providers and station are the other critical stakeholders from the procurement class since the fuel change option is the result of the design validation to be immediately executed for this project. Since the logistics of chemicals is outsourced and 3PLs and 4PLs in the hauliers class are responsible for transporting products, they can hinder the project development if they do not execute sustainable options. Because the design validation reveals that some of the options for some lanes are applicable only in combination with sustainable products the chemical product developers and coproducers can hinder the process if the sustainable product is not developed by them. Supply planners, marketing, sales and finance team are the primary stakeholders who can hinder the project at the first step in the execution phase.

First, a list of the stakeholders' classes is provided as well as the primary or secondary level of the engagement in further development of this project.

External classes:

- Trade party (Shell and customers): Primary
- Legislators and Political stakeholders: Primary
- Competitors: Secondary
- Investors Secondary
- Procurement facilitators: Secondary
- Society: Secondary
- Hauliers: Primary
- Terminals & container terminals: Secondary
- Co-producers: Secondary
- IDT[39] External: Secondary
- Consultants External: Secondary

Internal classes:

- Chemicals Land Logistics: Primary
- C&P Supply Logistic: Primary
- C&P E&S[40]: Secondary
- General managers of origin terminals at Shell: Secondary
- C&P Marketing: Primary
- C&P Business developers: Secondary
- C&P IDT Internal: Secondary
- C&P HSSE Logistic team: Primary
- C&P TBI[41]: Secondary
- C&P Sales: Primary
- C&P Finance: Primary
- Consultants Internal: Secondary

In the first section, the external stakeholder's engagement and in the next section a description of the internal stakeholder's relevance to this project is provided respectively for the stakeholders classes.

[39] Information and digital technology
[40] Economics and scheduling
[41] Transport and business information

Project owner at Shell

Since this project is accomplished at the request of the Shell C&P Land Logistics team as the first key player, it is propounded as the first stakeholder in the table to affect and also be affected by this project.

8.2.5 External stakeholders

The customers as one of the key players are one of the greatest stakeholders that will be severely affected by this project and required steps regarding their taste collection have been conducted in this project. From the design validation result, it is clear that not only the tier 1 customers but also the other customer tiers in the chain could be important for the acceptability of sustainable transport efforts.

In the legislator position group, three main stakeholders are involved. The European Commission is the party that is capable of executing the legislations regarding sustainability for the whole European industrial, energy, and transport community, and its targets for preventing climate change have directly affected conducting this project (Wilkinson, 1997). The Netherlands government's commitment to the UN climate change known as the Paris agreement for global warming limitation makes it to be aligned with the European Commission to make sustainability legislations and execute them in all sectors in the Netherlands (Zaken, 2014). The sustainability plans of the Netherlands government are legislated in the "Ministry of Economics and Climate Policy" and it proceeds to different companies in the Netherlands for making environmentally friendly businesses (Ministerie van Economische Zaken, 2011). Therefore, the chemicals Land logistics team as an internal team in the C&P department of Shell is affected by their commitment to developing sustainability measurements.

The competitors in the market involve the other product suppliers that may utilize other methods of transport with different levels of CO_2 emissions. Since this project affects important KPIs such as price and CO_2 emission it impacts the competitor's vision and activities since it can be an initiative for them to start stepping into the sustainable transport journey. It is stated by European Commission that the competitive sustainable transport market will be improved by 2050 (European Commission Competitive transport industry, 2016).

The investors of the Shell stock market will be affected by this project since adding sustainability to the transport will have a strategic effect on the market in the long term and the value of their share would be growth due to the economic growth as a result of this project as stated by "United Nation Knowledge Platform" (2020).

In the procurement position group, stations of sustainable fuel providers are involved as the stakeholders. Since the options of the hauliers for developing sustainable transport involve utilizing a couple of sustainable fuels for the trucks such as LNG, Bio-LNG, and HVO the producers and stations of such fuels will be affected by this project. Also, for the other practical sustainability option namely renewing trucks, the manufacturers of the trucks are affecting this project and by the further development of this project they will be affected since their produced trucks with enhanced engines will be used.

Some non-governmental organizations (NGO) and environmental associations that are the advertisers and developers of sustainable activities in all domains of industry and academic research, will be motivated by this project and it will be an incentive for them for taking the further development of this project or pursue any recommendations of this project in cooperation with research institutes. The citizens who protest against global warming and climate change resulting from CO_2 emissions are affecting and are affected by this project. They are socially supportive of developing sustainable activities in different parts of society and the industry. Stepping into

sustainable transport of chemical products by Shell affects their vision towards the chemicals department and specifically Shell company as a whole (Bellos et al., 2021). Also, Society is considered as people and the whole ecosystem will be affected by the lower amount of CO_2 emission (WordAtlas, 2020).

Shell is directly in contact with hauliers that are responsible for providing logistics services to Shell chemicals. However, in some situations, the haulier has to make connections with other logistics service providers to provide the required service to different customers over different distances. It mainly applies to the lanes that provide intermodal road-rail-road and road-barge-road options to be handled with rail and barge operators.

Since the hauliers provide logistics service to Shell chemicals, they are key players who affect the project significantly, the efforts of the business development have to be overseen by the commercial manager of all hauliers, the terminals where the products are loaded, and also the storage terminal. Moreover, the control and design of sustainable transport operations have to be handled by operation managers of all hauliers. The interaction between Shell and the haulier for sustainable transport will be managed by the customer service of the terminals. [redacted] container terminal will be impacted since the technical issues regarding the sustainable transport method has to be managed differently than conventional ways. In case of utilizing any of the sustainability options such as fuel changing, payload increasing, and renewing the trucks, the navigator will be responsible for tracking and tracing the product in the whole route.

Some product co-producers K and M will be also affected. Since the product they produce for Shell will be loaded in another amount in case of increasing the payload and also since the product is asked to be sustainable in addition to sustainable transport for some customers, for instance in case of the customer in lane G, the production and distribution from these co-producers will be affected. These co-producers need to be aware of any changes regarding the product type and amount of distributed product.

The TR application utilized by Shell chemicals for order placement and haulier arrangements is technically outsourced by data and information technology firms. Any desire for change in the terms of this application that will be part of the execution plan for the longer terms of this project development must be handled by them. This party is the secondary party that is not involved in the initial execution plan.

The consultant external company will be affected by the project development and execution and they will be consulted for this project development in further steps.

8.2.6 Internal stakeholders

The supply developer manager, planner, and the plan developer in the class of supply logistics will directly affect the project. They will also be affected by this project execution since this class has the responsibility for the planes of sustainable delivery methods. The E&S manager and the regional optimizer of the E&S department will be directly in contact with supply planners for economic justification of the sustainable transport method. The general managers from the loading sites need to be involved and approve any changes in the logistics of ordered products. The logistics coordinator from the C&P department- “Interviewee P1, Interviewee P2“- will be directly the conductor of this project. The marketing committee and market development manager from the marketing department will be responsible for customer negotiation plans and commercialization of this project in the connection with the customers in further developments. Since some of the options from the hauliers for sustainable delivery are utilizing LNG & HVO, the business developer for these fuels at Shell will be involved in the project. By this aim, the fuel of the sustainable delivery tucks can be

supplied from Shell itself from coming 2023, to 2024 (Interviewee P14[42], Pernis site visit, 20 June 2022). For the execution of this project, the new sustainable delivery options need to be visible to the customer in the Shell GS system for the customers who are willing to be delivered sustainably from the new contract. Therefore the IDT downstream department will be responsible for the execution of the goal in the ordering system of Shell. The sustainable delivery methods have to be approved by the HSSE advisor in the team. For this reason, the different technical consequences of the option have to be considered to satisfy the health, safety, security, and environmental values of Shell. It applies to the payload increase option. The transport of the products influences the prices and the payments. Therefore, the margins will be slightly different and the TBI will be responsible for releasing the new margins. All of the stakeholders in the sales position are directly and highly engaged in the project since their direct connection with the customers assists generation and expansion of a valuable sustainable transport system for the chemicals. Since the greatest impact of sustainable delivery is on the price, the C&P finance and transfer pricing of the financial department will be involved to assure the pricing policy is aligned with the corporate goals. Any technical, economic, legal, and marketing issues relevant to this project needs to be consulted with internal and external consultants before finalizing the execution to assure that all of the angles are considered in this project.

8.2.7 Stakeholders relationship map

According to the stakeholder relationship mapping methodology – Freeman- and by considering the classes of the stakeholders, the stakeholder relationship with the main focal stakeholder (the land logistics team) is mapped and shown in figure 8.2. This mapping is validated in a discussion with the project's second external supervisor. The letter "C" in front of some classes in this figure points out that the stakeholder is critical.

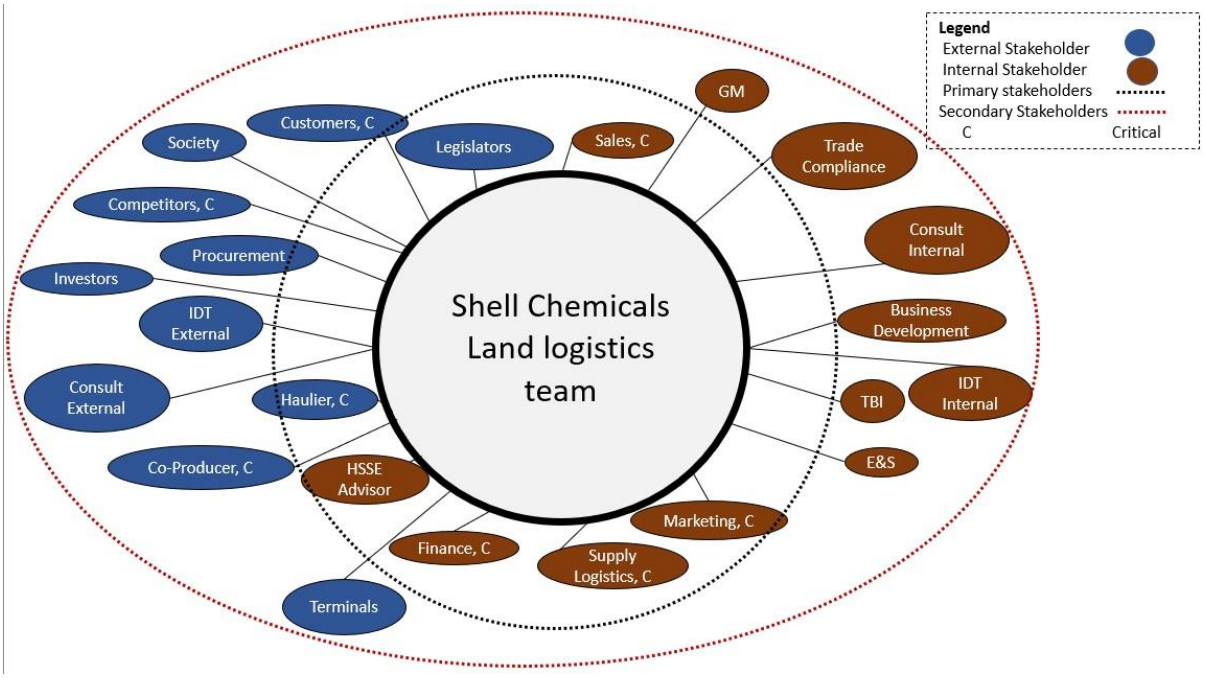


Figure 8.2: Stakeholders relation map
(Own figure)

According to Freeman, the project owner which is the chemicals land logistics team is located in the middle of the figure. Different other departments and parties involved in this project are drawn in the surrounding of this team distinguishable with different colors for internal and external parties.

[42] Materials and corrosion engineer at refinery site

Different stakeholders are located at different distances from the main circle and it stands for the depth of the relationship and network of different parties with the project owner in this project. The project development will be accomplished at the first stage in the internal system of Shell, distinguished by a black dotted line with a close relationship, and gradually in the next stages the domain of the project will become broader and more internal and external parties will be involved that allocate less strong relationships with the land logistics team. As it can be seen from the figure the external parties are located at longer distances than the internal parties in the secondary red dotted surroundings. It is important to consider these two groups and start further developing the project with the primary and expand by the secondary stakeholders to manage a complete plan for the execution.

8.2.8 Stakeholder Interest-Influence grid analysis

Power-Interest grid analysis for the stakeholders is a powerful analysis by which the policies for tackling the stakeholders and taking the appropriate strategy for any connection, negotiation, and obeying the legislations can be managed and planned (Walker et al., 2008). This analysis is based on the interest-influence model provided by Bryson (2004). The "interest" indicates the concerns about this project's development and "influence" indicates the power to affect the project.

To map the grid, the classification of the stakeholders generated in the previous section for stakeholder relationship analysis is used. This classification which is based on the position of the stakeholder defines how much interest and influence they would have in this project. Then, they are prioritized based on their interest in the project and their influence level. This analysis can be used to identify the power of the relevant actor and it facilitates the implementation plan and strategies for further development of the project (Brugha, 2000). This classification can be seen on the grid shown in figure 8.3 and after the figure, a description clarifies the position of the parties in this analysis.

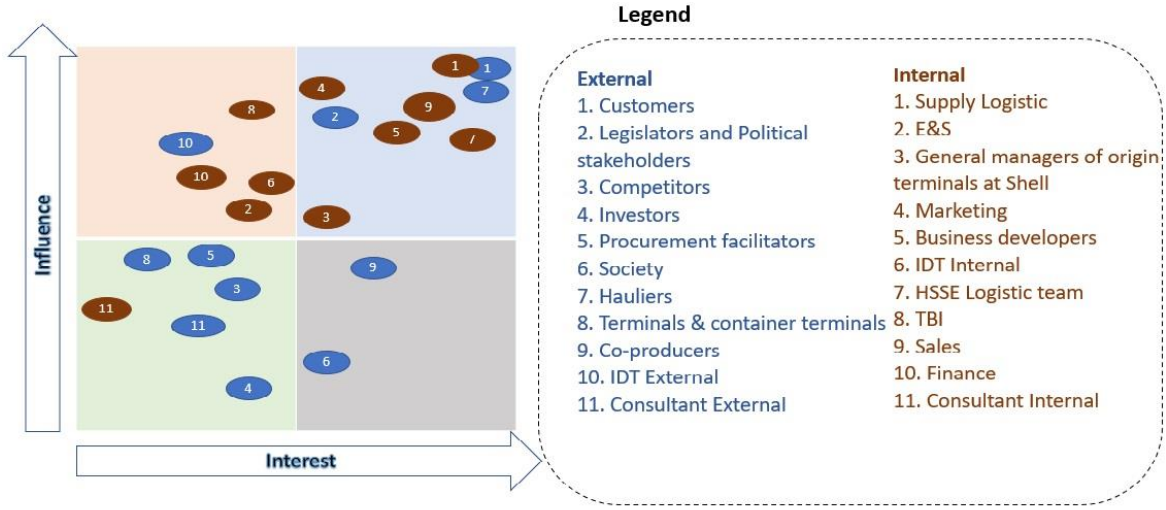


Figure 8.3: Interest-influence grid for stakeholder classes
(Own figure)

As it can be seen from the Interest-Influence grid, for external stakeholders, the majority of the stakeholders have high interest and influence placed in the blue quarter. From the external stakeholders, the trade parties and hauliers have the biggest interest and influence on the project. The relationship with the stakeholders in the blue quarter has to be managed closely (Brugha, 2000). The society known as the population and the investors have relatively the lowest influence. The requirements of the stakeholders in the orange quarter need to be met and for the green quarter,

they need to be taken into account. The stakeholders in the grey quarter of the grid need to be informed about this project's execution.

From the internal stakeholders, it is obvious that they have rather a high impact on the project since they are placed in the orange and blue quarters. The lowest interest in this project is for the consult firms, whereas their advice influences the project.

Interest-Influence comparison of Internal-External parties

By comparing the interest-Influence grid, it can be concluded that the influence of the internal departments of Shell on this project is more than external parties. This is because this project could be implemented and executed in team-based activities involving different sub-departments such as marketing, supply chain, etc at the C&P department. Adding sustainable logistics to the decision-making system and bearing the consequences requires the cooperation of several departments that could be a primary or secondary stakeholder. The internal stakeholders affect and also they will be affected by this project. The external parties' level of interest and influence vary in the grid. This is because some parties only affect the project and some others will be only affected by this project explained in the description of external and internal stakeholders.

8.3 The growth strategy and market effect

This project is accomplished for improving the decisions in assigning the transport for delivering Shell's chemicals products to the European customers. The objectives of the land logistics team from safe and reliable transport of the products are improved by adding sustainability concept to the transport. Therefore, investigating the growth strategy of this project assists in organizing, planning, and implementing the project to achieve the long-term goal of market exploration. There are a couple of methods by which the growth strategy can be probed. In the following, the best fit method is utilized to map the growth strategy for the land logistics team.

8.3.1 Growth strategy model

In order to provide a practical overview of the growth strategy and market exploration, an initial review of the available data from the project and the chemicals logistics market in Europe is conducted. This review assists in the selection of the growth strategy and market analysis model. There are different models by which growth strategy can be investigated such as BCG[43], McKinsey's Three Horizons of Growth model, and Airtable's growth experience. In table 8.2 an overview of each model is provided.

Table 8.2: Growth strategy and market explorations methods

Method	Narrative	Requirements
McKinsey's Three Horizons of Growth	• Three horizon template • Manage the current performance while considering the future growth opportunities and the methods for accomplishing them all at the same time	Current opportunity Future opportunities and essential steps for them
BCG	• Matrix developed in 1968 • A framework assists companies in managing their portfolio & budget prioritizing across the units in the business	Market explorer growth and market share numbers
Airtable's growth experience	• Providing a structural framework for running growing opportunities	Steps taken in the domain of the project

McKinsey's three Horizons of Growth model is suitable for the data from this project and for investigating the market influence and the methods by which the Shell chemicals group reaches its

[43] Boston Consulting Group

objectives (Gavieiro Besteiro, 2022). Since the project is simultaneously being investigated by the current growth opportunities this model is beneficial. A couple of features of this model relevant to this project are as follows:

- Fostering the culture of sustainability
- Creating a framework for achieving strategic initiatives
- Preparation for sustainable logistics development plan

BCG is a practical model for the prioritization analysis of this project and the customer segments, sustainable delivery service, and marketing channels requirements for this project implementation (Duică et al., 2014). However, since the main requirement of this model is the numerical data of the stock market value and the market explorer for the growth rates, it is not used.

Airtable's growth experience method is not applicable in the case of this project since as mentioned earlier, this project is in the initial phase of studying and investigating (Airtable, n.d.). No steps are taken for the project implementation to be accounted for as running experiments.

8.3.2 Applying McKinsey's Three Horizons of Growth to the current project of Land Logistics

According to the McKinsey model, there are three horizons in which the performance, ideas, and the exploring of the market are mapped in a time (Gavieiro Besteiro, 2022). This model is not sequential but it voices the necessity of the focus on the current performance and thinking about the future tactical and strategic ideas in horizons 2 and 3. An overview of the horizons for the Shell land logistics team on this project is mapped in figure 8.4. The required information for making this figure is the current performance of the land logistics team captured from chapter 4, stakeholder analysis captured from the previous section in the current chapter, and the design and market information for the chemicals logistics that will be explained in horizon 3. This project is part of the growth strategy and some other measurements are required to explore the market. The ideas for each horizon are:

1. Horizon 1: Since the idea of this project is to develop a business process based on the currently available performance, the current core performance in horizon one has to be maintained and strengthened as operational objectives.
2. Horizon 2: In horizon 2 the expansions and new business opportunities need to be discovered and explored. For this project, the development of sustainable delivery and the decisions for the selection of the proper sustainable option need to be explored as tactical objectives.
3. Horizon 3: In horizon 3 the new viable possibilities need to be genuinely created. In this horizon, the market will be affected as a strategic goal.

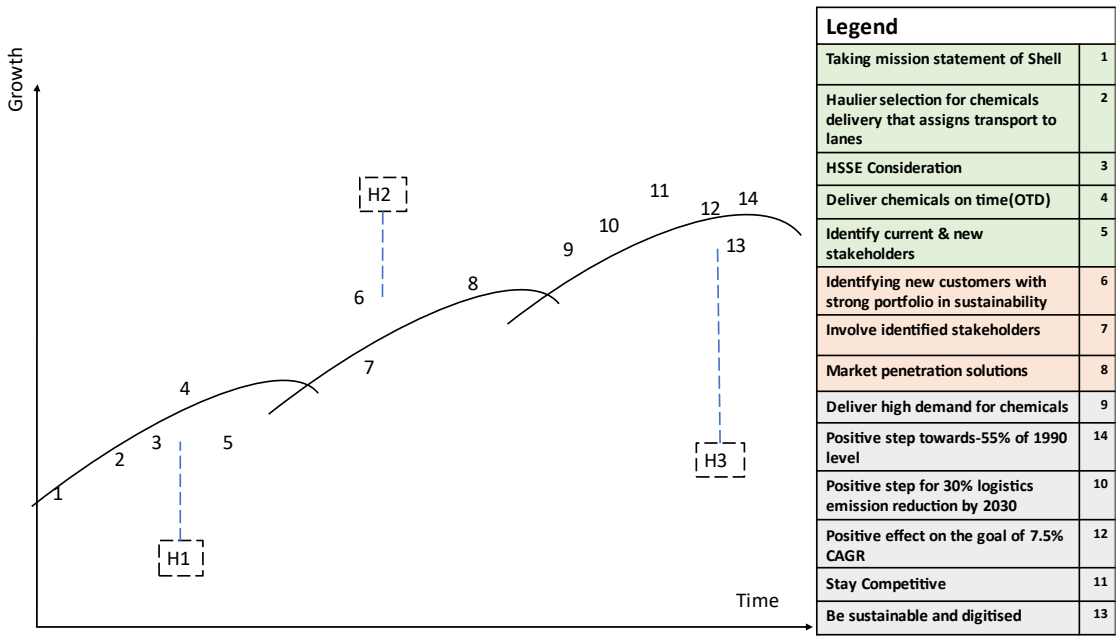


Figure 8.4: Growth strategy and market exploration of this project
(Own figure)

This McKinsey's horizons diagram presents the current idea perspective for the growth of the land logistics team employing this project and some other important requirements in three horizons (McKinsy & Company, 2009). The first one named H1 in the figure shows the current main performance of the land logistics team at Shell. The H2, the second horizon, is about the tactical measurements that are derived from the current performance activities and requirements of market exploration of this project in H3. New customers with a strong portfolio in sustainable performance are suggested to be identified in H2. This identification is managed based on the current customers' portfolio and the market exploration that requires customers with a strong portfolio in sustainability. In this phase, communication with the stakeholders will be performed to smooth the way toward the execution stage. In order to achieve a strategic outcome of this project and gain greater dominance, it is important to investigate and plan for penetration strategies. Some penetration tactics for the logistics performance would be as follows:

- Logistics price adjustments: For the logistics team in isolation without considering products, the adjustment of the new prices to the after Corona situation can assist in improving the logistics performance. Also, it is important to develop sustainable products as an important requirement of different customers to encourage the customers to select sustainable transport besides the sustainable product.
- Distribution channels examination that in this project is accounted to hauliers, 4PLs or possible 5PLS: In addition, since the logistics for chemicals is outsourced and control on logistics angles is low, it is constructive to examine the hauliers by their standard operation procedures, their planning, and forecasting portfolio, their competitiveness in the market and their connections with the 4PLs or possible 5PLs. According to what is gained from the hauliers' examination of the Shell chemicals land logistics team, requests for boosting logistics performance could be shared with hauliers and they would try to satisfy Shell's requirement. A suggestion for better examination of the hauliers is that requesting (Wheel-to-tank) WTT emissions that in sum to (Wheel-to-tank) WTT emission gives a holistic view of the emissions.
- Marketing channels for the chemicals products and the product promotion: As the chemicals are transported via the hauliers, the product promotion affects the sales and accordingly the

distribution of them. The promotion and marketing regarding the product quality and performance will influence the customers' quantity and accordingly the logistics of that product towards the customer.

Horizon H3 is the horizon on which the growth will occur. The growth of the land logistics team in this project will not happen in isolation. Since it is reliant on chemical products, due to the increasing demand for chemicals the land logistics team will be able to deliver more frequently to the customers with high demand (Allied Market Research, 2020). As stated in H2 the new customer identification will affect this aim positively.

The chemical logistics market is segmented by transport mode, service, geography, and end customer. The transportation product to the customer is part of the service segment that is influenced by the other segments (Mordor Intelligence, 2021). The end customer of the products will be affected by the project execution since the sustainability price will be spread in the entire supply chain and they will need to pay more for green delivery. Also, it can be part of their scorecard and they can claim that they support sustainable delivery. For Shell chemical products in this project, the pharmaceutical industry, automotive industry, cosmetics industry, etc are the end users affected by this project implementation. From the geography segment different customers in different EU locations, will be affected by project execution, and depending on their geographical location different sustainable transport options can be provided to them. In other words, their accessibility to transport mode facilities is one of the factors that determine the sustainability option in their lanes (Mordor Intelligence, 2021).

As stated in the introduction chapter this project is aligned with the aim of the market for the reduction of logistics emissions to 55% below the 1990 level and also the land logistics team aims for 30% logistics emission reduction by 2030.

According to the report from "Mordor Intelligence" in the base year of 2021, the European chemicals logistics market compound annual growth rate (CAGR) is expected to grow by 7.5% by 2025 as a growing market. It entails that due to the growing demand for chemicals logistics plays an important role in the transport of chemicals to geographically spread customers in Europe and it is important for efficient and sustainable market development (Mordor Intelligence, 2021). This project addresses sustainable and reliable chemical transport that is aligned with the market goals.

Also, in anticipation of the market of chemical products logistics, it is stated that the utilization of different transport methods will be increased for roadways, railways, and waterways in anticipation until 2027 (Allied Market Research, 2020). This is because the demand for chemical products will increase the demand for transporting them to the customers. It can happen due to urbanization, infrastructural development, and rising industrialization that propels the growth of the chemicals logistics market (Verified Market Research, 2021). However, the legislation of the European Commission is activated in terms of logistics sustainability for reaching the goal of 55% below of 1990 level by 2030 (European Commission transport emission, 2019). Therefore, this project as the initial step toward the development of sustainable transport will positively affect the chemicals logistics market.

By adding sustainability to the chemicals logistics portfolio the growth in the market will occur by maintaining the current competitive advantages and fostering them accordingly (Gupta & Benson, 2011). The current competitive advantages of chemical delivery in high-quality, safe and reliable methods have to be fostered according to the new market requirements (Shell Delivery competitive strategy, 2013). Adding the competitive advantage of sustainable transport will guarantee growth in the market. In the current situation, the sustainability factor is immature especially in the logistics because of the challenges in this area it can be considered as a gap in the market, and fostering the

activities compatible with the sustainability factor presents Shell chemicals the competitive advantage (Taticchi et al., 2013).

As stated by interviewee P15, the HSSE and advisor of the C&P department, digitalization is being under development to make the order and delivery process automated (Interviewee P15, Monthly meeting, march 12, 2022). This will impact the logistics system fundamentally and it can be considered a competitive advantage that presents the team market exploration.

Lastly, to achieve market exploration in the third horizon, the European Commission states that making a strategic value chain for the green transition of the chemicals has to be planned as well as the engagement with the stakeholders to take their tastes and anticipate the market trends (European Union, 2020). The first one is presented in the H1 and H2 of the McKinsey model which will result in the market exploration of H3. McKinsey's model perfectly presents the planning of this project for future progress in the market.

8.4 Strategic evaluation of this project

To evaluate the strategicness of this project the framework introduced by Hunger & L.Wheelen (2020) is utilized. For this evaluation first, the elements of the strategic management process will be introduced and the alignment of the steps in this project will with those elements is described. Figure 8.5 shows a strategic planning process.

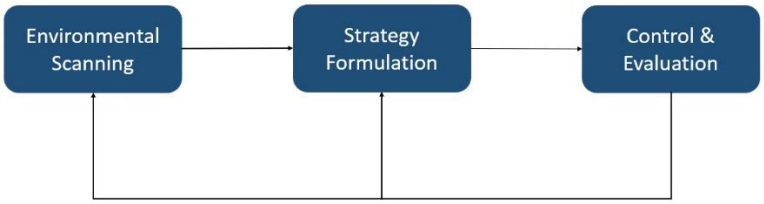


Figure 8.5: Strategic project features
(Hunger & L.Wheelen, 2020)

The adjusted BPDM method used for accomplishing this project is a comprehensive scheme of strategic planning to gain a strategic outcome from this project. Below the mentioned points from Hunger & L.Wheelen shown is the figure are analyzed for the strategic outcome of this project.

- Environmental Scanning: This term entails the monitorisation and dissemination of the information from the examined environment. In the first chapter, the Shell company mission and the main activities of the chemicals HSSE and Logistics department are mapped. Also, the current setting analysis of chapter 4 in detail has keyed the general trends of the decision-making system that leads to assigning the transport modes to the lanes.
- Strategy formulation and implementation: In Chapter 5 the strategy for obtaining required and good-to-know information for the design and in chapter 7 for the design validation is provided. Also, the way how the strategy is implemented via questionnaires is shown in the UML activity diagram. By strategy implementation, all required info for the design is collected from the hauliers and classified.
- Control and Evaluation: In chapter 5 and chapter 7 the haulier and validation questionnaires are profoundly evaluated and the data is controlled for completeness and compliance with Shell data according to the adjusted BPDM methodology that encompasses gates after each stage.

Since the process of accomplishing this project is strategic, the outcome of the design for the selection of the applicable sustainable transport method is also strategic (Hunger & L.Wheelen, 2020). The decision-making system is improved by sustainability criteria and it is aligned with the

European commission climate change prevention target that is strategically planned for the long-term perspective.

Since this project is an approach toward a long-term target associated with sustainability and global warming prevention, it is considered a strategic project. According to Unite nation general assembly in the nineteenth special session, transportation would be the main driving point for growing energy demand in the world and this demand needs to be satisfied in an environmentally sustainable way (Sustainable Development Goals Knowledge Platform, 2020). Outcomes will be built upon each other to make the transition toward sustainable chemical transportation to the customers (Garza, 2013). By making the lanes sustainable by a couple of specific options suggested by business prosses application on lanes such as fuel change, fossil fuel as a non-renewable limited environmental resource will be protected for the future and it is another strategic outcome of this project.

8.5 SWOT analysis

Applying the SWOT analysis can strategically assess the project achievements for improved decision's quality in terms of sustainability and its effect on cost, OTD, and CO_2 reduction (Sarsby, 2016). SWOT analysis can be utilized for strategic planning by considering the strengths, weaknesses, opportunities, and threats of this project. In this analysis strengths are identified with the aim of fostering them, weaknesses are identified with the aim of leveraging them to make an opportunity from them or to improve them and available opportunities are identified to benefit from them. Also, the impending threats as probable barriers to the project development are identified with the aim of controlling and mitigating their negative effect. Figure 8.6 shows a schematic of the SWOT analysis for the development of the decision-making support system in this project. For making this scheme all of the findings from hauliers, validation data, and all managerial quotes input are considered and the SWOT analysis is brainstormed shown in the below figure.

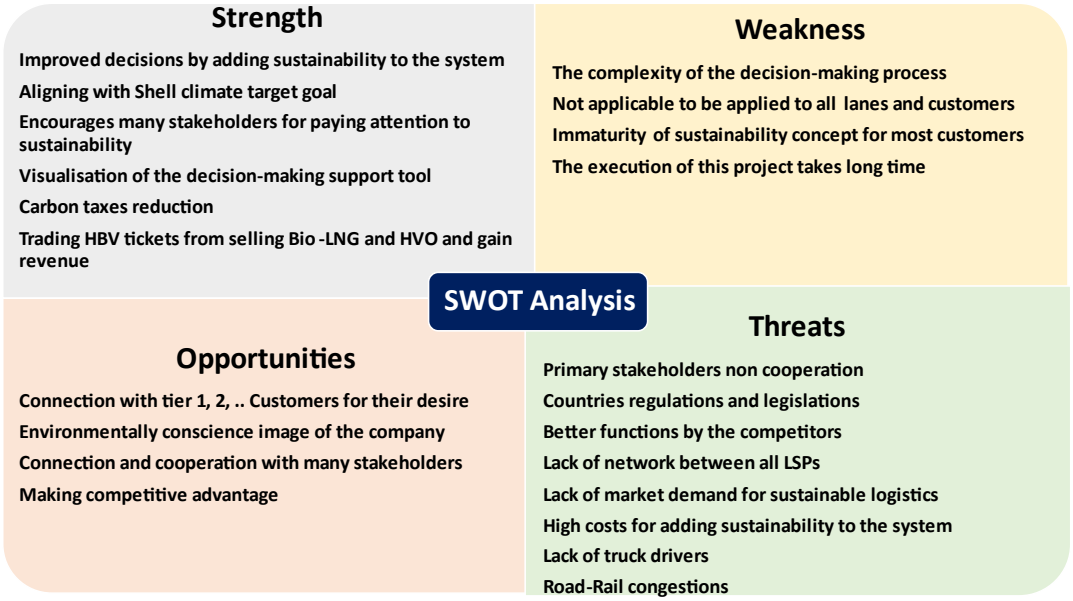


Figure 8.6: SWOT analysis of this project

Strength:

- Improved decisions by adding sustainability to the system: The first main strength point of developing the decision-making business process is the involvement of sustainability criteria and improvement of the quality of the decisions. Sustainability is nowadays trendy among all sectors of industry.

- Aligning with Shell climate target goal: As stated before in this project Shell chemicals is aiming at a reduction of 50% of the logistics CO_2 emission by 2030. With the assistance of the decision-making business process the chemicals sustainable transport method will be added to the logistical system of Shell.
- Encourages many stakeholders for paying attention to sustainability: As it is obvious in the stakeholder analysis there is a great number of internal and external stakeholders classified into different classes. Connection to them for the aim of execution of this project reminds the importance of sustainability and makes them pay attention to this goal for collaborative project implementation.
- Visualisation of the decision-making business process: The visualization of the decision-making system in word and a visualized process improves the understanding of the decision process for selecting the most applicable transport option.
- Recently for the aim of emission restriction Shell has applied a carbon pricing system on the operations with scope 1 and 2 emissions in the "Sky scenario" to recognize the importance of climate change prevention and human wellbeing because of the effects of the CO_2 on the human's life (Sky Scenario, 2022). This emission calculation is based on (Well-to-wheel)WTW emissions. It is expected that by 2030 many regions adapt the pricing policy and it will cover scope 3 emissions for indirect emissions of chemicals. So, it is expected that chemical logistics has to pay for the emissions from the transportation of the chemicals in the coming years. Executing this project and expanding it to different other lanes will be beneficial for the team since lower TTW emissions provided in this project as part of WTW, will lead to a lower amount to be paid for lower emissions (Skuce, 2015).
- The sustainable logistics option of fuel change that is provided in the design is beneficial for Shell. From 2023 Shell produces and sells HVO and Bio-LNG fuels. Additional revenues will be provided because of these fuel sales, providing HBE[44] tickets, and trading the tickets that bring value to the logistics of chemicals (Interviewee P2, personal communication, July 14, 2022).

Weakness:

- Complexity of the decision-making process: Adding the design to the main decision-making system increases the complexity of the process since this designed business process is an additive to the main system. Also, additional KPIs and consequences make the decision complex.
- Not applicable to be applied for all lanes and customers: The design is not generalizable to all of the lanes. Since the options for the other lanes might differ, the requirements and consequences for KPIs differ that are not investigated in this project. Also, some customers are not ready yet for fostering sustainability in their portfolio. Therefore, the decision-making business process does not work for them and the old fashion conventional transport method has to be utilized for them. From the result of the design application on the lanes, the product features are not important. However, as is mentioned in the visualized process of the design the option must not make a hazard to the product. It applies to hazardous products. The hazardous products and difficulty in managing HSSE requirements for them make it difficult to apply some options such as electric trucks.
- Immaturity of sustainable logistics concept for most customers: According to another conclusion made from the validation questionnaires sustainable logistics is still immature

[44] HBE: Dutch word "hernieuwbare brandstofeenheden". Utilises for bio fuels.

among the parties of the whole supply chain and the burden of educating the customers is on Shell since it is at the beginning of the chain as the raw material supplier. The consequences of additive sustainability KPI are not acceptable for some of the customers.

- Cannot be applied in a short time: The decision-making business process requires a lot of time to be applied to the system. A lot of stakeholders are involved and communicating with them for making a concrete execution plan requires long-term managerial input and effort. The execution of this project starts in September 2022. However, finalizing the process of sustainable transport involved in the current system takes a long time.

Opportunity:

- Connection with Customers in different tiers: This is a factor that can be considered as an opportunity since connecting the customers in the chain and educating them about the project aim and importance of sustainable logistics and their achievements from this project can make the consensus about their investments in sustainable logistics activities.
- Environmentally conscience image of the company: By adding sustainability in the decisions that Shell C&P land logistics team makes for the selection of the hauliers and accordingly assigning a transport method to the lanes and executing the design, the project scope will become broader and other primary and secondary stakeholders will be involved. This execution is an opportunity by which sustainable logistics will be added to Shell's business portfolio and the sustainability image of chemicals departments and accordingly Shell company will increase. It is also beneficial for the customers and they can claim to address sustainable delivery by which they can enhance the content of their scorecard and prove their attention to improving sustainability. This is explained in depth in section 8.9.
- Connection and cooperation with many stakeholders: As can be seen in the stakeholder analysis many stakeholders are involved in this project and will be connected for the execution. By connecting to them there will be an opportunity to expand the strategic goal of sustainability improvements and make close cooperation for intensive sustainability improvement in logistics.
- Making competitive advantage: Since not many companies have developed sustainable activities in the logistics sector, taking steps in this area can give a competitive advantage to Shell C&P land logistics team to benefit from the strategic long-term effects. Although the initial investment in sustainability is high, it will provide long-term strategic effects. According to the study accomplished by Rassier & Earnhart (2011) and Pham et al (2021), environmentally friendly activities can influence the financial performance of firms in the long term because of aligning with society's demand, lower charges for CO_2 taxes as well as lower maintenance costs for the sustainable performing equipment such as the trucks. The trucks with biofuels require lower maintenance costs than trucks with diesel fuel (Says, 2021). Hallstedt et al (2013) argue that involving the sustainability aims in the firm's business performance adds long-term success for the firm. The reason is the management of the resources to be used for delivering chemicals to the customers (Utilising self-produced HVO and Bio-LNG at Shell) and considering new European commission regulations that will be announced shortly regarding taxes (European Commission transport emission, 2019). Aligning with sustainability strategies increases the survival chance of the Shell C&P department in the future for the growing sustainability concept. Also, as stated by Shimizu & Sakaguchi (2013) the payload increase of the trucks will decrease the cost per metric ton of the product and delivery frequency. This strategic outcome will be the result of aligning with

the society's desire for reduction of emissions providing a competitive advantage to Shell C&P department.

Threats:

- Primary stakeholders, not cooperation: Primary stakeholders are important stakeholders and close cooperation is required with them to improve the blueprint for the execution and further development of this project. As it is shown in the stakeholder analysis figure the primary stakeholders for the development of this project are the internal teams from the C&P department. In case of weak cooperation, it will be a threat to further execution and this project will be terminated in the initial stages of the execution or it will be prolonged which is not in favor of the land logistics team.
- Countries regulations and legislations: According to what is developed in the decision-making business process the country's legislation is important for the application of the payload option on the lanes. Each country's regulation for the limit of the total payload and not ability to utilize this option can be a threat for the lanes that this is the only option for them.
- Better Functions of the competitors: If the competitors can provide sustainable delivery at a lower cost or better OTD reliability with higher CO_2 reduction, it will be a threat to this project and further execution will be difficult since the customers will be hardly convinced when the competitors provide them better functions.
- Lack of network between all hauliers: Some of the hauliers (3PL) of the Shell chemicals department have a contract with another haulier (4PL) to transport the chemicals. The lack of a good network between them can be a threat. In other words, not good communication between them can lead to misinterpreting of the data and OTD can be affected negatively. It leads to commercial conflicts and for low performance of OTD discounts have to be provided to the customers (Interviewee P7[45], Personal discussion, July 6, 2022). Also, in terms of late delivery recognized as a disruption the production might be stopped and postponed because of not existence of raw materials in the customers' production sites, the customers of the customers (tier 2 customers) will be affected by late deliveries as well. So, the other customers in the chain will be also affected more significantly known as the snowball effect (Katsaliaki et al., 2021).
- Lack of market demand for sustainable logistics: If the market demand for sustainable logistics is low, it is difficult to expand the spectrum of this project since it will not be welcomed in the market and it is a threat to further execution of this project. Shell is able to control this issue partly by impacting the stakeholders and the customers chain and enhancing their awareness about this project and the benefits of sustainable logistics for them. These benefits are mentioned in the next chapter in sub-section 8.7.2.
- High initial costs for adding sustainability to the system: In implementing this project there will be some barriers that can be considered an obstacle. Since the main driver of this project is the sustainability KPI affecting the other KPIs, the main obstacles are related to the sustainability aim. According to what is obtained from the discussion with the sales managers sustainability cost is not acceptable for many parties in the market while sustainability aims required a high initial investment Pham et al (2021). However, the long-term strategic outcome is sometimes neglected and this is the reason why objections to this project development might occur as a threat to further execution of this project. A solution to

[45] Senior Marketing manager in C&P department

control and mitigate this threat is to educate the customers about the long-term strategic financial effects mentioned previously in the last point of opportunity of this SWOT analysis.

- Lack of truck drivers: The logistics in Europe encounters the shortage of truck drivers that is occurring due to concerns about the health and the drivers' ability to work (Staats et al., 2017; Cefic chemical trends, 2022). It happens due to poor work condition and mental and physical strains or even the high price of taking the appropriate driving license. A significant part of the governance of this issue is by the EU and the national regulations (Staats et al., 2017). This issue leads to longer lead-time and in many cases delays in product delivery. Since OTD is an important KPI any problem resulting in minimizing the value of this KPI will prevent further development of this project because it will not be acceptable to Shell and the customers. This issue can be partly managed by Shell and it can develop a blueprint for training the drivers and employment guarantee after the training. This training and recruitment can be provided individually by Shell and by the alliances between different companies such as Shell and the hauliers, other chemical companies, and national governments. Improving their work condition such as well facilitated trucks and work hours and longer vacation lengths can also lead to overcoming this issue by the drivers' recruiters. Addressing all those items cannot be accomplished just by companies but since the driver shortage is experienced by all European countries, a more powerful initiative has to be placed by national legislators and governments at the macro level.

- Road and Rail congestions: This item is a threat to the OTD KPI. Road traffics and allocating the majority of the rails to the passengers' transportation leads to remarkable delays in chemical transport that are detrimental to Shell's image and financial improvements because of providing compensation discount to the customers for the delay (Interviewee P16[46], personal communication, July 8, 2022). Road and rail congestion is an infrastructure problem at the macro level (Pittman et al., 2020). Therefore, governmental subsidies and attracting private investments in this area can be helpful to improve the infrastructure. In this area, the Shell Chemicals department will not be able to tackle this issue (Narayanan et al., 2018).

8.6 Implementation Plan

In this section, the complexity of the project execution is mentioned and an implementation plan for the first step towards this project execution is provided based on discussion with primary stakeholders. In the UML diagram in this section, the involvement of the important primary stakeholders in the execution of this project and their activity sequence is elaborated. Moreover, the concepts that should be used in the negotiation with the customers to smooth the agreement between Shell and the customer are pointed out.

8.6.1 Complexity of the project implementation

According to Pigosso et al (2013) utilizing pilots (business plans) in sustainability projects and developing anchored practices from them is a struggle point for many companies. Although sustainable practices are considered to be an important goal of many corporates, the execution of the practices is challenging (Epstein & Buhovac, 2010). Høgevold et al (2015) argue that in the development and execution of a sustainable business model the corporate culture and the business model have to be shifted which is difficult to be managed. This exactly points out the disagreements about the importance of sustainable logistics among different teams in the C&P department. Although the implementation of this project on a big scale requires a lot of time and effort, it is doable to start the development from a small scale as what this thesis project presents in the

[46] Senior financial manager at C&P department

decision business process validation chapter and in the next execution phases the domain can be gradually expanded to broader scopes with involvement of all lanes, hauliers and customers.

8.6.2 Implementation plan suggestion method and required data

The objective of this project implementation for the land logistics team of the Shell C&P department is the reduction of part of the scope 3 emission and alignment with the C&P department's goal of 50% transport emission reduction by 2025. The implementation plan suggested to Shell for planning the project is in form of a project flow in a UML activity diagram in which the sequence of the activities required for implementing this project by involved entities are proposed (Fakhroutdinov, 2022).

The initiation phase of entity determination has to be done for mapping the UML diagram. What is required to be accomplished for this step is to utilize the findings from the stakeholder analysis to get the required primary stakeholders involved. According to stakeholder analysis in section 8.2.7 the project owner, land logistics team, marketing, finance, sales managers commercialization, and supply planners of the C&P department are the primary internal stakeholders that need to involve in this project execution at the first stage. The required information for making this UML diagram is collected from personal discussions with the relevant employees of the primary stakeholders. Personal conversations have been conducted with the supply planner team manager (Interviewee P17, personal discussion, July 13, 2022), the financial manager (Interviewee P16, personal discussion, July 8, 2022), Marketing manager and commercialization (Interviewee P7, personal discussion, July 6, 2022) and the sales managers during the validation questionnaires discussions. The names of the sales managers are provided in the spreadsheet of the validation questionnaire analysis. Figure 8.7 shows an overview of the UML diagram for the project execution.

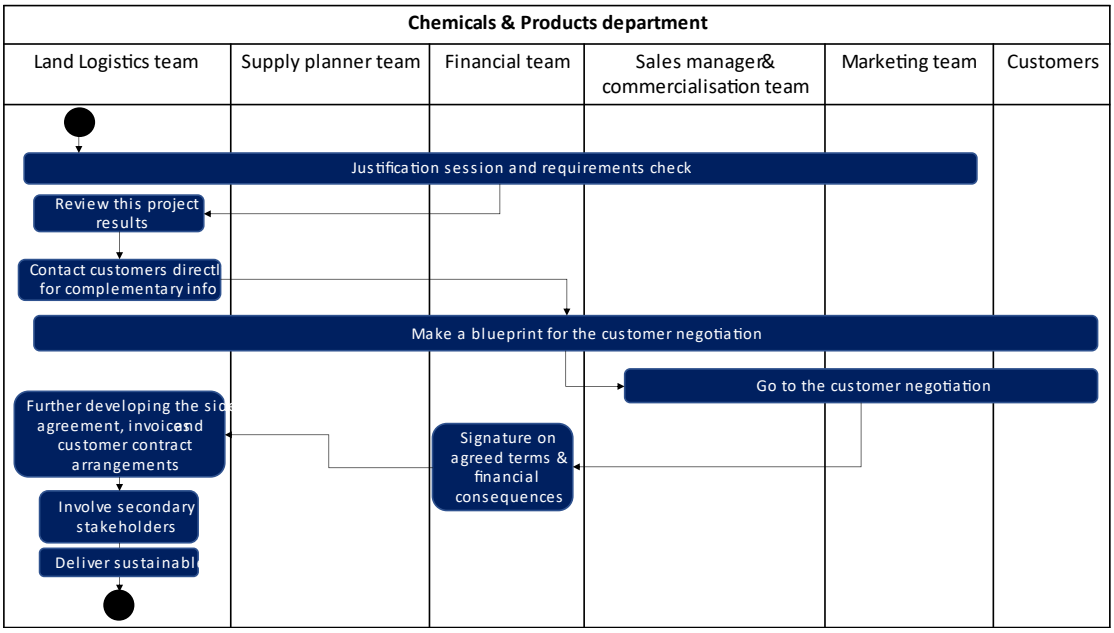


Figure 8.7:UML diagram of implementation plan suggestion
(Own diagram)

According to this activity diagram, a justification session needs to be developed between all mentioned teams in the diagram as primary stakeholders to

- Make awareness about the mandate of this project execution and the importance of sustainable logistics
- Align all primary stakeholders about the importance of this project execution

- Introduce this project and the findings
- Define the involvement of each team and their role in the execution plan
- Make an incentive in the involved teams by defining the land logistics team's aim for the reduction of CO_2 in the logistics to obtain an intense cooperation
- Check the requirement from each department's perspective for adopting the business process designed in this project
- Decide about the sustainability certificate to be provided to the customers as the guarantee for delivering in a green way.

Then the land logistics team will need to review the results of the finding in this project for doable lanes from the design application on the lanes (design validation results). Especially for the payload increase option that in section 8.7 more details about this matter are provided.

Then all mentioned teams in the UML diagram have to make a blueprint all together with information from this project and each team's specific terms and conditions. The financial team will help in the generation of the blueprint and financial terms in that. The supply planners will observe and verify the features of the new sustainable transport. After negotiation of the marketing and the sales commercialization team with the customer the agreed terms have to be signed by the financial managers to obtain their confirmation. Next, the side agreement for the hauliers, invoice, or contract terms arrangement for the customers will be required to be accomplished by the land logistics team and afterward, the relevant secondary stakeholders must be involved. External coproducers, IDT team, E&S, General managers of origin terminals at Shell, Business developers, and TBI of the C&P department as the secondary stakeholders need to be involved in the further execution steps of this project which are not covered in this report.

8.7 Framework an action

According to the design, some constraints have to be taken into account for a successful negotiation planning associated with the payload increase option described as follows:

- Customer storage tank: These constraints must be controlled in a direct connection with the customer to assure the maximum product that the customer can be delivered in one time delivery since the sales managers were not able to assure us precisely about this matter.
- Since Germany is the destination location for two customers that the payload increase option will probably be applicable for them, and the legal constraints must be checked with the local agents in Germany. Any technical requirement such as the truck wight without the load and the types of the trucks are required that must be checked in a connection with the haulier and the customer parallelly since for the lighter trucks the payload could be increased more than for heavy trucks (Interviewee P2, personal discussion, June 15, 2022).

8.7.1 Calculation of the logistics price from the total price

There is a possibility to make the negotiation with the customer more convincing by providing changing in the price to accept the logistics sustainability option since the total price change is very small and it can be leveraged to direct the negotiations. In table 8.3 the share of the logistics price from the total is provided for each product group, it is synchronized for the lanes in the result of the design validation. The required data for making this table is the share of logistics from the total price obtained from the discussion with sales managers, and the data provided by hauliers in "haulier responses" spreadsheet for the price increase and the effect of changes on the total price is calculated that can be utilized in the negotiation.

LPST: Logistics price Share from Total%
ΔL: Logistics Price increase %
Change in the total price = ΔT= (LPST)(ΔL)

Table 8.3: Change in the total price by applying sustainable options from design validation

Product Line	Share of the logistics price from the total price	Applicable sustainable transport options	logistics price increase provided by the haulier %	Change in the total price %
Solvent	3-6%	Diesel->HVO	3-13.70%	0.09-0.822
		Diesel->Bio-LNG	3-5%	0.09-0.3
		Diesel->LNG	3-5%	0.09-0.3
		Renewing trucks	6.90%	0.207- 0.414
PODer	3-4%	Diesel->HVO	0.69 %	0.0207-0.0276
Styrene Monomer	2-3%	Diesel->Bio-LNG	14.87%-25.18%	0.2956-0.7554
		Renewing trucks	10.45%	0.209-0.3135
Solvent	3-6%	Payload increase	0	0
Heavy Olefins	2-3%	Payload increase	0	0

8.7.2 Customer benefit from this project

This project and serving sustainable delivery is beneficial not only for Shell but also for the customers. It is because they can claim to address sustainable delivery by which the content of their scorecard can be enhanced and the customer attention for improving sustainability in logistics can be proofed. Moreover, what can be proven is the contribution to the future of the next generations and leverage actions and scales by modifying the company standards to environmentally friendly activities as well as their alignment with governmental and regional commitments to the Paris agreement.

8.7.3 Implementation plan flow diagram after the last step of the design

The UML diagram provided at the beginning of this chapter provides a broad scheme of the activity flows for executing this project. Figure 8.8 shows a more specified activity flow to be considered in Sep-Oct 2022 for implementing this project. The required info for making this figure is the same as the UML diagram as the discussion with the primary stakeholders. This activity flow diagram starts from the end of the design when the option is considered to be executed in September 2022 shown in the light blue color rectangle in figure 8.8.

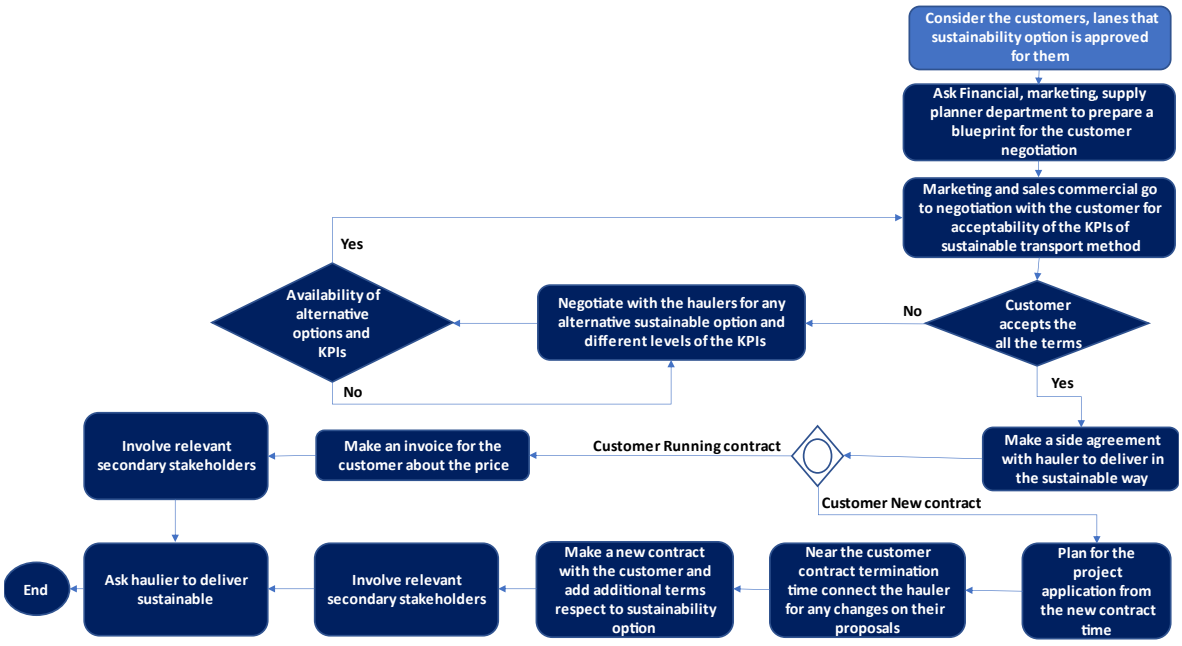


Figure 8.8: flow diagram of project implementation
(Own figure)

The Land logistics team aims to accomplish this project with the current setting and without thinking about new haulier and new customers for this project execution. This team is resolute in making the chemicals logistics sustainable for the lanes as the result of the design validation provided in table 7.2. This is the reason why the negotiation loop with the hauliers and customers continues till an agreement is achieved shown in the loop in figure 8.8. When the terms are agreed upon between Shell and the customer, a side agreement with the hauliers is required to be made. Depending on the customer's desire sustainable delivery can be used in the running contract or from the new contract. The rest steps in both situations are mentioned clearly in the figure. For the customers that are willing to be delivered sustainably from the new contract, the relevant secondary stakeholders are suggested to be involved to adjust the team's activity flow with each other and fill the requirements for all the teams relevant to this project which is out of the scope of this project. After that, the secondary stakeholders can be involved such as the IDT team for applying changes in the GS and TR as internal systems of Shell to make the sustainable delivery visible on the order & delivery platform of Shell and after that the command for sustainable transport will be sent to the hauliers.

8.8 Measurements in the Macro and Micro levels for logistical CO_2 reduction

There are a set of measurements in the technology or structure level that can be taken at the governmental and legislative authorities (macro) and company (micro) level for further execution of this project. As stated before in this project the legislators are the primary stakeholder that affects the involvement of sustainable transport in the fleet significantly. They are associated with power and position in the infrastructure development for supporting sustainable transport. Also, the internal stakeholders' involvement in this project is investigated in stakeholder analysis. All the information from the hauliers' input and design, managerial input, and data from SWOT analysis are collected and the study of Aronsson & Huge Brodin (2006) is utilized for the generation of figure 8.9. This figure assists the Shell land logistics team to identify the required measurements at macro and micro levels for fostering not only the design validation results but also other options and lanes involved in this project.

	Technology	Structure
Macro Perspective	- Minimize fuel utilization with high emissions such as fossil fuels - Standardisation of load and vehicles - Create possibilities for all industries to apply sustainable logistics	- Serious Legislation in the EU for the application of green transport - Infrastructure, e.g road-rail and water network and traffic control - Increase awareness about the impact of sustainable logistics in all industries - Increase possibilities for Modal shift - Training and recruiting Truck drivers
Micro Perspective	- Fuel technology altering to be green - Standardization of the vehicles and loads for better planning - Develop sustainable products in combination with the sustainable logistics	- Fleet structure utilization (domain of this project) - Payload increasing for logistics demand reduction - Make alliances and collaboration for recruiting truck drivers - Improve awareness about the benefits of sustainable logistics among internal stakeholders

Figure 8.9: Measurements in the Macro and Micro levels to mitigate the threats and make all sustainability options applicable
(Aronsson & Huge Brodin, 2006)

8.9 Value of the design of the decision-making business process

Although the design will be added to the current decision-making system and make it more complicated, it encompasses value and leads to business growth since sustainability will be addressed as the result of the design and it is aligned with the aim of the land logistics team for addressing 50% lower direct emission by 2025. According to the scorecard of Shell, provided in figure 8.10 addressing sustainability and lower CO_2 emissions is an important performance metric that results in an effective outcome (Shell Scorecard, 2017). This scorecard applied to all departments at Shell company.

Sustainable development	Operational excellence	Cash flow from operating activities

Figure 8.10: The terms of the Shell scorecard
(Shell Scorecard, 2017)

The lanes provided in table 7.2 can directly after this project become sustainable. It assists the land logistics team to achieve its goal of 50% emission reduction by 2025. What the design shows is 13.60% emission reduction for all lanes with direct road and intermodal transport and if the result of the design as only direct road emission is considered, the emission reduction will be approximately 19% while the logistics price increases on average by 6%. Since the share of the logistics is maximum of 6% from the total price that the customers are charged, this total price will be increased by 0.36% which is a very insignificant number and the land logistics team can leverage it in the discussions with other teams in the C&P department to smooth the project implementation process. Moreover, the gains from this project are aligned with the second term of the mission statement of Shell as a whole and the land logistics of C&P department can claim that they are planning to align with this statement to reduce part of the scope 3 of emissions. This project is the first step with valuable outcomes that initiates the Shell chemicals delivery with lower emissions.

8.10 Sub-conclusion

In this chapter, a more general analysis is accomplished for this project to fulfill the project sub-activity 5. This project has a strategic outcome for addressing sustainability in the logistics of chemicals to the customers. The growth strategy is analyzed and suggested for the success of this project and market exploration. This analysis shows that the land logistics team has to take the three horizons into account currently for a successful outcome of the project. Since logistics is cannot be

considered solely the measurements such as planning for promotion of the green products and attracting customers with a strong portfolio in sustainability can lead to market exploration. The other analysis is stakeholder analysis which illustrates the primary and secondary stakeholders that are affecting and will be affected by the project. Also, the impact-interest grid shows how different classes of stakeholders impact and are interested in developing this project looks like. The SWOT analysis is the other analysis applied to this project. The threats must be taken into account since they can make an obstacle to the further execution of this project. The opportunities can be utilized for obtaining the most out of this project and the strengths must be kept and fostered for achieving competitive advantage from this project. Moreover, in this chapter the project sub-activity 6 is fulfilled as a plan for the implementation of this project. For this proposal, the primary stakeholders identified at the beginning of this chapter are utilized and since they are all at Shell, the initial discussion with them occurred to come up with the proposal for the implementation of this project in September 2022. The steps of the implementation plan for primary stakeholders are presented in a UML diagram. Also, a framework action is presented to consider for the negotiation regarding the payload option, the share of the logistics price from the total, and the customer benefits from this project. Furthermore, a broader scope is considered to map the measurements that at macro and micro levels can be taken to utilize all of the sustainability options and achieve the land logistics target goal for 2025.

9 Conclusion and Recommendation

In this chapter, the findings of this project are summarised to answer the project sub-activities and questions. This project is accomplished by the request of the Shell C&P land logistics team for a decision business process that contains sustainability, cost, and OTD for assisting the land logistics team on how to select the most appropriate transport options balancing the KPIs that are executable on the lanes from September 2022. Since the sustainability KPI is the dominant factor that affects the other two KPIs, these three factors are considered to be the KPIs in this project. According to the literature review, there is a design gap in addressing decisions based on three main KPIs entailing no existence of instruction for the land logistics team on how to select the most appropriate and applicable transport method for the lanes. According to the design approach of this project, the main project activity is generated:

"Design of a decision-making business process balancing sustainability, cost and OTD KPIs for transport method selection of Shell chemicals"

Since this is a design project, the adjusted BPDM methodology is generated and used in this project which is from the guidelines of Dym & Little methodology, considerations of this features and combination with the stage gate method and the project sub-activities and questions are derived from this methodology.

9.1 Conclusions

To address the main project activity the composed project sub-activities and questions are fulfilled as follows:

Project sub-activity 1: "Analyse the current process of assigning the transport methods to the lanes and outbound logistics portfolio."
This project activity is fulfilled in chapter 4. The current decision-making system analysis is conducted through the analysis of the way how the transport methods are being selected currently for delivering chemicals to European customers. For this analysis, the information from the internal system of Shell in form of discussions with the project external supervisors, mentor and transport coordinator are used. This analysis reveals that among payload, lead time and cost the cheapest haulier is selected to be responsible for a specific lane which leads to assigning a transport method to that lane. So, the transport method is not in the consideration of Shell and they do not select between transport methods and CO_2 emission is not considered as another factor in this system. Also, it emerged that the hauliers are all outsourced and for further information, direct contact with the hauliers is required. What the land logistics aim to do is to consider the pre-determined hauliers for the lanes from the current setting, contact them and investigate the available sustainability options and their applicability for the relevant lane. Moreover, the database of 2021 is utilized for current outbound logistics analysis to capture detailed information about the entire lane encompassing the loading site, haulier, product, customer name and country and city location, and the current transport method. For this analysis, the lanes with the majority of deliveries are selected to be involved since they affect the CO_2 footprint significantly. What this analysis shows is that there are 4 main loading sites in the Netherlands that are the departure point of the majority of the products shown in table 4.3 and different direct and intermodal transport methods exist in the outbound logistics portfolio of chemicals transportation that are analysed for representative lanes in the next project sub-activity.

Project sub-activity 2: "Fulfil the requirement for the design of decision-making business process."

To fulfill this activity first the design context is defined. The land logistics team, hauliers, and customers are identified as the key players. This is considered multi-criteria decision-making since different sustainability options have different effects on the KPIs and a selection between them makes it a multi-criteria decision in which the sustainable transport options are variables and KPIs are the criteria. This project activity encompasses two sub-questions which are answered sequentially to state the requirement for the design.

Project question 2.1: "What are the possible sustainable transport options?"
To fulfill this question, some findings from the current setting analysis in **Project activity 1** are utilized. Since the hauliers are outsourced and Shell has no clue about the available options the questionnaires are generated for hauliers to gain an insight into the available options. With the aim of data and workload management and also receiving as much as complete data from the hauliers, a set of specific customers and their lane features are selected from the analyzed outbound logistics as representatives. The criteria asked in the questionnaire are about the options available for the lane, their influence on the KPI, and any additional comments, certainty, and time framework of the option. The first one clarified this project activity. The questionnaires are shared via e-mail and the findings from the questionnaires show that there are different factors affecting the type of sustainability option the hauliers provided shown in figure 5.6. Analysis of the options shows that the majority of the options are fuel change for diesel to HVO, Bio-LNG and LNG. The payload increase was the other option after the fuel change. Electric trucks, intermodal, and renewing trucks options were respectively the other options provided by the hauliers.

Project question 2.2: "How the KPIs are affected by the options?"
The other criteria asked in the hauliers questionnaires are the influence of the options on the KPIs considered in this project. The hauliers were asked to provide numbers for the CO_2 emissions, the price increase, and how the OTD is affected, certainty and execution time of the option. For OTD it is asked to provide how many more days the option requires for on-time delivery. The responses to these questions differ for each haulier and each lane. Figure 5.6 shows the factors impacting the options and KPIs. A different analysis is applied to the responses to obtain the greatest influencer on the emission, the most expensive option, and also the most polluting lane. All provided options will reduce the CO_2 emission and they will indue cost increase for the logistics except the payload increase option. The options are compared for their price and effect on CO_2 reduction provided in figure 5.9. The most expensive option is the intermodal option and the least expensive one is the payload increase with no effect on the logistics price. It emerges that the only option that impacts the OTD negatively is the intermodal option. The performance of different hauliers in providing different options and the comparison between the CO_2 emission reduction and price are respectively provided in figures 5.8 and 5.9. "Hoyer" and "Bertschi" hauliers are the only hauliers that are already providing intermodal options that produce low CO_2 emissions. Moreover, the lanes are compared currently and after the option for their CO_2 emission provided in figures 5.10 and 5.11.

Project sub-activity 3: "Design the decision-making business process."
In this project sub-activity, the decision business process is designed. Since this is a specific case for Shell and there are other factors than the three considered KPIs that play important role in the selection of the most appropriate transport method, Shell and customers are not the only parties that affect the applicability of an option for a specific lane and a lot of flexibility is required to come up with the design, the mind mapping is utilized for the design. The first required data for generating this design is the info from **Project sub-activity 2**. The hauliers' responses for the options, affected KPIs and their additional comments with respect to the options, certainty, and time framework for the execution are utilized. The second type of data for making this design is de input from discussions

with Shell staff containing sales managers, project external supervisors, and mentor. The design occurred per option. The factors from the option are requirements, consequences, certainty, and the time framework for the implementation of the option. The discussion with Shell staff emerged that there are additional factors that affect the applicability of the option for a lane, such as the customer portfolio in sustainability, price in the market by competitors, and the existence of sustainable products to be delivered to the customer. What emerged from the design is that adding sustainability to the lanes is complicated. For this design, the aim of the land logistics team for early execution of the design is considered and the options that require long time arrangement and negotiations are suggested to be excluded and the conventional transport method to be used for those lanes. Also, for the customers that are not willing to be delivered sustainably, negotiations in a longer time are required which enforces utilization of conventional transport method for the coming months. Moreover, if the option affects OTD significantly and the customer is not able to place the order early enough, if the options require the customer adequate technical requirements and the customer is not equipped with such technical requirements for example gig storages tanks and if the market and competitors do not allow for price increase above a certain point the conventional transport method is suggested to be utilized. An overview of the complete consideration of the design is provided in chapter 6. After providing the design, a verification table has checked the required elements in the design.

Project sub-activity 4: "Validate the design"
This project activity is accomplished by making the validation from what is designed in **Project sub-activity 3.** What is required to be done for this validation is to use the design in the previous activity and apply it to the lanes and compare the result with hauliers' responses for the lanes. For this validation, the lanes that were in the haulier questionnaires are collected and questionnaires are generated from the info on the hauliers' questionnaires about the options and affected KPIs. In the questionnaire, the acceptable price increase according to the CO_2 reduction is asked. Also, the contractual opportunity on the option and the likelihood that the option and its factors are acceptable, are asked. Moreover, for the options affecting OTD, the earliest moment that the customer can place the order is asked as well as the acceptable logistical price increase in case of utilizing electric trucks. These questionnaires are filled in individual discussions with sales managers responsible for each customer in order to validate and assure the involvement of additional factors about the market, product, and the customer portfolio and obtain any additional comments from the sales managers about the specifications of the customers. The design is applied to the lanes toward the customers and the requirements, consequences, certainty, and time framework as well as the additional factors are considered for each customer. The finding from the validation shows that for 7 lanes the options will be applicable to be applied and Shell can select them to be applied on the lanes. It shows that the fuel change options, payload, and renewing trucks are the options that are applicable for execution in September 2022. Also, the additional factor of the sustainable product is required in order to make the option applied. In this validation, the aim of the land logistics team for early execution of the design is applied and for the lanes that options require long time arrangements, using the conventional transport method is suggested according to the design.

Project sub-activity 5: "Analyse the project generally."
There are some beneficial analyses by which the findings from the design and entire project can be evaluated. Those means are stakeholder analysis, McKinsey growth strategy analysis, the strategic outcome of this project, SWOT analysis, and the measurements for improving the acceptability of different sustainability options at the macro and micro levels. The stakeholder analysis shows that a large number of the stakeholders will be involved in this project and initially the primary stakeholders are in close relation with the land logistics team and secondary stakeholders are at

longer distance entailing further stakeholders in further development of this project. The McKinsey growth strategy shows that the current planning for developing this project in the three horizons will lead to market exploration. This development must consist of a set of additional measurements such as the involvement of new customers with great ambition in sustainability and the development of market penetration solutions. Since logistics cannot be considered solely for successful growth, the market penetration regarding product promotions affects it significantly to take the strategic outcome of this project. The weakness and threats from the SWOT analysis could become a barrier for this project and some measurements at micro and macro levels could be taken to damp them and leverage them for making progress in addressing sustainable logistics compromising all sustainable options.

Project sub-activity 6: "Propose implementation plan for the design execution."
The information regarding the implementation plan is applicable for Shell in the further execution of this project. For that, The information from the **Project sub-activity 5** is utilized to connect to the identified primary stakeholders at Shell. Also, the findings from the design validation in Project sub-activity 4 are utilized to review the main and additional factors for utilizing fuel change, payload increase, and renewing truck options. Investigating both of these items leads to a plan for further development of this project provided in a UML and in more depth in a flow diagram in chapter 8. The implementation plan shows that the involvement of the primary stakeholders at Shell is essential for the generation of a blueprint for customer negotiation, and managing a formal negotiation. After approval for accepting the new situation the plan must be verified and signed by financial managers and after this step, some additional steps for haulier and customers have to be taken that are shown in detail in figure 8.8 to deliver the products in a sustainable way to the customers.

9.1.1 Fulfilling the main project activity

The main project activity is to design a decision-making business process for the land logistics team for transporting chemicals to European customers. The decision-making business process is developed and provided in form of text and a map. This design guides the Shell land logistics team on how to select the most appropriate transport option for each lane.

9.1.2 Connection of the project objectives and results with sub-activities and questions

All of the project sub-activities and questions are derived from the BPDM design methodology that respectively defines the problem, determines the requirement for making the design, makes the design of the decision-making business process and validate it. Then the implementation plan is suggested based on the general analysis of the project and the design. In more detail, in chapter 2 the objectives of this project are pointed out as an investigating different sustainable transport methods and providing a decision-making business process to support selecting the most appropriate transport method for a lane. The former is fulfilled in the project sub-activity 2 that shows all of the options for all representative lanes which can reduce the CO_2 by 40% and increase the logistics price by 45.36%. The latter is fulfilled in the project sub-activity 3 which presents the decision-making business process in form of word and then it is visualised in a process. The design validation shows that only 3 types of sustainable transport options are applicable for representative lanes that is fulfilled in sub-activity 4. This validation shows that the design is associated with 13.6% total emission reduction and 6% logistics price increase. The maximum share of logistics from total price is 6% and accordingly it contributes to a maximum of 0.36% total price increase by which the customer is charged. Therefore, the project goal is addressed by following all the sub-activities and questions.

9.2 Conclusion from the entire project and findings

Shell land logistics team is eager to address sustainability in the transportation of chemicals to the customers. However, there is no explicit instruction on how to decide about the transport method for a lane that contains balanced KPIs of sustainability, cost and OTD. Currently, there is no procedure for transport methods selection and selecting the hauliers leads to assigning a transport method to a lane. This decision-making process is made and visualized in this project. The analysis of hauliers responses as the requirement of the design shows that the most expensive options for sustainable logistics are the modal shift from direct road to intermodal transport and electric trucks while they affect the CO_2 reduction remarkably. Whereas, the fuel change, payload increase and renewing trucks options do not increase the logistics price significantly and they can be scaled up very soon. Addressing sustainable transport is a complicated matter and in the design, the aim of the land logistics team for the execution of this project in September 2022 is considered. In addition to the main factors relevant to the options containing cost, reduced CO_2 and OTD, this project introduces some other factors relevant to the options except the three main KPIs namely “main factors” and other factors namely “additional factors” relative to the customers portfolio in sustainability, the logistics price in the market and existence of sustainable product that need to be considered beside main factors derived from the options. Shell is at the beginning of the supply chain and for acceptance of sustainable logistics, the other customers and consumers in the chain must accept this development.

The intermodal transport option is the least welcomed option by the customers and Shell because of high managerial input, long time required for arrangement and negatively affected OTD. Nevertheless, it can be considered for a longer time for execution in the coming years. Using the electric trucks is an option that encounters significant uncertainty and the willingness of the customer and Shell for utilizing this type of truck is very low. In most cases, logistics cannot be considered solely without the product and for already sustainable chemical products utilizing sustainable transport is a plus point. The lanes selected for this project accomplishment are the representative of all the lanes in the portfolio. The design resulted in immediate application of the fuel change to HVO, LNG and Bio-LNG, payload increasing and renewing trucks options for 7 lanes from 14 lanes that the design were applied on them. The results show that by the design 13.60% CO_2 footprint reduction will be achieved for all the lanes with current direct road and intermodal transport. For this footprint reduction the total price that the customer pays to Shell will increase maximum 0.36% which is not a significant amount. Moreover, Shell can benefit from this project by maximising the customer charge to 1% and trading the tickets that can be achieved in agreement with the hauliers for fuelling Shell produced HVO and Bio-LNG to their trucks.

During the entire project time, different conversations with hauliers and internal staff of Shell have been conducted. According to these discussions it can be concluded that the main focus is on the decarbonisation of the product and all teams in the department are not aligned about the importance of sustainable logistics. For further execution of this project it is essential to make this alignment and involve these primary stakeholders from C&P department to take the first and most important step in the project execution.

9.3 Reflection and Limitations

This project is established based on the request of the land logistics team of the C&P department of Shell. Since the important lanes were proposed by the team to be focused on in this project the outcome will not be generalizable to other studies. However, many facts, specifications, and acceptability of the findings about options for making the logistics sustainable would not be disproved. In the following, the reflection and limitations of this thesis project are provided.

This project gave me an opportunity to work on a real problem feeling in a accompany. Working at Shell provided me a valuable experience that I was not able to gain it in other places. The way how the logistics is arranged for transporting chemical products, how robust the network is among different teams in the C&P department of Shell, serving a project in an international diversified teamwork are the most valuable learnings from conducting this thesis project at Shell. Also, I have learned how the importance is put on sustainable logistics from Shell, haulier and customer perspectives. Moreover, I have learned how the discussions should be conducted in the professional setting with co-workers and how the work has to be reported regularly to the line manager which could not be achieved in the university setting in discussion with fellow students and professors. I learned how to adapt to the new environment and how managed criticism leads to improvements.

A reflection of the notion of sustainable logistics for the entire chemicals industry is to invest more in developments of awareness about the importance of sustainable logistics. The results from this project can be utilized to improve the awareness about the total price change which is very small and the total effect on the CO_2 reduction which is about 19% in this project.

The time constraints for this broad project spectrum have been a deterrent factor in accomplishing a profound project. These constraints have led to the inability in obtaining enough information from the external LSPs and also internal teams in the C&P department for accomplishing the very accurate and complete numerical analysis for both hauliers and validation questionnaires. In both of the questionnaires, some information is missing such as the pricing and CO_2 reduction in hauliers forms and the “no idea” term from the sales managers in the validation questionnaires.

Regarding accessing the correct information at Shell, accessing the right staff to communicate the information has been a concern. Due to the hierarchy system of Shell and even between all teams of the C&P department and allocation of the pre-determined task to specific persons in a team, finding the correct person who can cooperate and provide info for this project accomplishment was a concern. Also, this project is the first step toward sustainable chemical transport in the department and there was no clue about how to conduct the project at Shell. Many steps are not documented and collecting accurate data for mapping them took a lot of time. It applies to this project for mapping the processes that are drawn in discussion with different staff of Shell C&P department.

Regarding the lanes that were involved in this project, it was tried to keep the number of representative lanes as small as possible to make the project load manageable and also receive the input from the hauliers as complete as it can be. Therefore, the small representative lanes from the outbound logistics portfolio were involved in the design.

Regarding the types of required data from the hauliers and the sales managers, many types of responses were given that some of which were not applicable. This issue has happened to open questions in both haulier and sales managers’ responses that were requiring very technical replication. Although for both the response time-limit has been determined, the correct data was not given on time and intensive telephone calls, skype, and Microsoft teams connections have been conducted to take the correct data. In addition, the sales manager did not respond to the questionnaires without a face-to-face or online meeting and a discussion. These matters have prolonged the data collection process to be 2 months instead of 10 days for hauliers and 1,5 months for sales managers instead of 1 week.

Lastly, although the results would be sufficient for this project, the lack of cooperation of some sales managers for filling validation questionnaires because of the different perspectives about the importance of sustainable logistics compared to the product, has led to investigating a lower number of the lanes than what was in the hauliers questionnaires and this matter has to be taken into account in the implementation and future development of this project.

9.4 Recommendation

According to the findings of this project and acknowledged limitations of this project a set of recommendations for further projects are inferred.

In this project, just the sustainability, cost, and OTD are taken into account as the Shell desired KPIs. As a recommendation, the other KPIs such as risk and safety can be investigated and added to the decision-making system.

In the current project, the focus is on the development of decision-making business process from the current available hauliers and customers for Shell. In further studies, the logistics service providers can be the focus of the study and a compatible synchro-modal network with new hauliers can be studied to be synchronized for product delivery by considering important KPIs for Shell.

In the implementation plan proposal of this project, the primary stakeholders are involved for proposal of the project implementation plan. However, it can be recommended that the planning for this project execution to be studied in another separated project in depth for all primary and secondary involved stakeholders and to be simulated via programming and IoT.

The stakeholder analysis in this study can be a good initiative for a specific study only focused on the stakeholders of any product group, such as the PODer group, in detail. So, as a recommendation, for further studies, the stakeholder analysis can be considered to be accomplished profoundly relative to this study.

Applying the design on the lanes to validate it showed that the sustainability options work for the lanes that have direct road transportation method. Intermodal options are already sustainable and putting effort for making them more sustainable is time keeping and difficult. Therefore, for the next projects, development and also execution of this project it is recommended to consider lanes with direct road transport to use the sustainability options and make them environmentally sustainable.

Since it is concluded from this project that the sustainability of the product itself is in the attention of the customers and Shell, it can be recommended that for the next studies the sustainability of the total product line and the supply chain be investigated. For this aim, a product group such as PODer can be studied profoundly in a specific project.

Since it is concluded that the tier 2 customers' desire is also an important criterion that has to be taken into account for some lanes, for the subsequent projects the tier 1 and tier 2 customers' desires regarding the sustainable product, production process, logistics, and also production specifications such as the product they produce, the volume of production, their row material and final product storage capacity is recommended to be studied in depth in a specific project.

Since the CO_2 emission in this study is based on the tank-to-wheel (TTW), a more focused study for studying emissions for one haulier and its specific sustainability options can provide a better understanding of the wheel-to-tank (WTT) and in total well-to-wheel (WTW) emissions. This recommendation for further studies required very close cooperation with the considered hauliers.

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