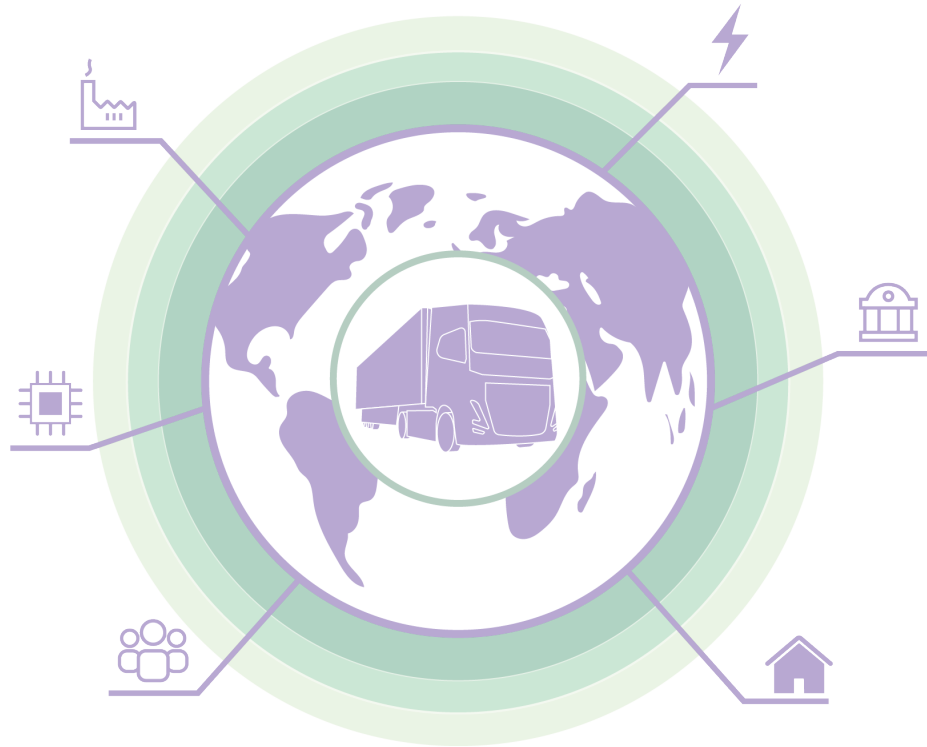




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Scenario Building as a Tool for Future-Oriented Product Design

Exploring the Use of Scenarios in Industrial Design: A Case Study of the Truck and Trailer Industries

Master's thesis in Industrial Design Engineering

Daniel Arfvidsson Nilsson & Alicia Sjödin

DEPARTMENT OF INDUSTRIAL AND MATERIALS SCIENCE
DIVISION DESIGN & HUMAN FACTORS

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Abstract

The world is constantly changing and adapting to technological innovations and societal events. Since we cannot predict the future with certainty, designing for the future poses a significant challenge. Despite this, there is limited research describing how scenario planning can be used in future-oriented design. This project aims to explore how future scenarios can serve as a creative tool for design. Conducted in collaboration with Volvo Group, the project focuses on the design of trucks and trailers as a case study.

This project employs an exploratory approach, integrating *Futures Thinking* and *Design Thinking*. Information was gathered through expert interviews and trend research, reading from a wide variety of sources. The subsequent trend analysis focused on a selected set of *megatrends* and *catalysts*, which provided the foundation for scenario construction. Drawing inspiration from the Swedish Energy Agency's report, *Four Futures*, its scenario format was used as a template. Using methods such as "*If this is true, what else is true?*", the relationships between trends were mapped and explored. Finally, three scenarios were constructed, which then served as the basis for developing two design concepts. The concepts were then evaluated by a focus group of designers at Volvo Group. To evaluate the scenarios they were compared against a set of criteria: *plausibility, consistency, distinctness, comprehensibility, time and effort involved* and *degree of integration*.

The results showed that the scenarios met the criteria but revealed another weakness in the design process. The focus group called for a design method that more thoroughly incorporates the scenarios into the designs.

To further explore how to utilise scenarios in design work, the next step could be to investigate the best methods for transitioning from scenario to product. Specifically, this involves finding ways to develop designs that fully integrate and reflect the information contained in the scenarios.

Keywords: Megatrends, Catalysts, Futures Thinking, Design Thinking, Scenario Planning.

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Daniel Arfvidsson Nilsson & Alicia Sjödin, Gothenburg, June 2024

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1

Introduction

The world is always changing, whether it's through technological innovation, political events or natural phenomena. Consequently, companies need to continually adapt in order to survive; they must try to understand how society may change and what this might entail for the company's business. However, the different industries work within different time frames. For example, in IT development, products can be updated and changed quickly. This makes the industry very flexible and enables an agile work method. However, in many industries product development has long life cycles; it takes a long time from the start of development to a product launch. An example is the automotive industry in which the development process takes several years. Therefore, it is often necessary to design for an anticipated future — not the present. Companies operating with such long time frames must base their decisions on future predictions.

There are various methods of prediction, both qualitative and quantitative. Which method is appropriate to use varies depending on the industry, the set time frames and what purpose the predictions are meant to serve. In some cases, the desired result is a single course of events with the highest probability. In other cases, creating a variety of predictions may be more beneficial. For example, forecasting utilises historical data and trends to estimate the most likely development. The result is quantitative. The method is most useful in relatively stable industries and typically applied for short- to medium-term planning. To make a qualitative prediction, scenario planning is a common method. The method is based on developing several, internally consistent descriptions of possible futures. This approach can help organisations prepare for several possible outcomes and react more effectively. It is particularly useful in uncertain industries and often used for long-term planning (SAP, n.d.).

Moreover, scenarios can also serve as a creative tool, inspiring innovative thinking (SAP, n.d.) Scenario planning, is a commonly used method among designers. However, there is not much research describing how it can be used in future-oriented design (Schwartz, 2023). Therefore, investigating methods of building scenarios for product design may be of value.

1.1 Volvo Group's Innovation Work

Volvo Group is continuously working with future innovations, both in terms of improving their existing product range and developing future solutions. This work is often focused on either the current market or visions of a far-off future. However, Volvo Group is working to bridge the gap between these two timeframes within the company. A current innovation project, driven by Martin Claesson (HD Platform Vision and Strategy), aims to complement other current innovation projects in the company and explore new work methods. This is done by investigating future opportunity areas for Volvo in small exploratory projects, called probes, with a timeframe of 9-17 years into the future. This master thesis is meant to contribute to this larger innovation project.

For this project, we have been asked to develop a design based on the assumption that Volvo Group would begin designing trailers and other products related to them. Today, the handling of delivered goods is often automated in warehouses, but trucks are not adapted to fit into these automated systems; on- and offloading is done manually. Creating a complete design for the entire vehicle may provide new benefits to customers and create a cohesive user experience for their users, from loading to unloading the trucks. Investigating what potential new products Volvo Group could produce — trailers or related products — could be a first step towards the company creating these complete vehicle designs.

1.2 Project Aim

The aim of this project was to test a method of scenario building to form a basis for design, using the case of trucks and trailers, as a part of Volvo Group's innovation project. We were to create several scenarios that describe possible future worlds. The descriptions were to illustrate larger societal changes but also changes specific to the truck and trailer industries. The purpose was to explore how societal developments may affect these industries. The scenarios were then to be used to develop concepts of one or more products or services, either physical or digital.

1.3 Research Questions

This project aims to answer the following research questions:

1. How may current trends impact future scenarios surrounding trailer and truck design?
2. Will the chosen method of scenario building produce a useful basis for design?

2

Theoretical framework

This chapter presents a theoretical background to the report. It presents different ways in which organisations can work with future planning, how designing for the future can be done, which categories of trends there are and finally the theoretical approach used for this project.

2.1 Planning for the Future

Understanding the future is a complex task, considering the endless amount of variables and dependencies shaping the future. In order to navigate this, companies can adopt various approaches to innovation and strategic planning. Börjeson et al. (2006) propose three different categories of forecasting approaches: predictive, exploratory and normative. They address the questions, respectively: which answer the questions respectively: “*What will happen?*”, “*What can happen?*” and “*How can a specific target be reached?*” (p. 725). In other words, predictive analyses are made when you want to predict the most likely future and form a response based on that prediction. Exploratory analyses are primarily made when exploring several potential futures with a wider scope and longer time frame. Normative analyses are made when you aim for a specific goal and want to investigate how to achieve it.

All of these approaches can be used to create future scenarios that can help organisations navigate developments as they unfold. To utilise them in a structured manner, there are methods of categorising different possible futures. One example is the Futures Cone, which is a model used to illustrate the diverging nature of future possibilities Gall et al. (2022) present their version of this model (see figure 1), which is an amalgamation of many previous future cone models. The cone itself is exponential, indicating that the number of possible futures increases exponentially as one looks further into the future. Within this cone, different trajectories, dependent on varying world events, lead to different scenarios set in a specific time period. Depending on how uncertain these scenarios are, they could be anything from probable to preposterous. The scenarios could also be part of a preferred future, which could have any range of probability (Gall et al., 2022).

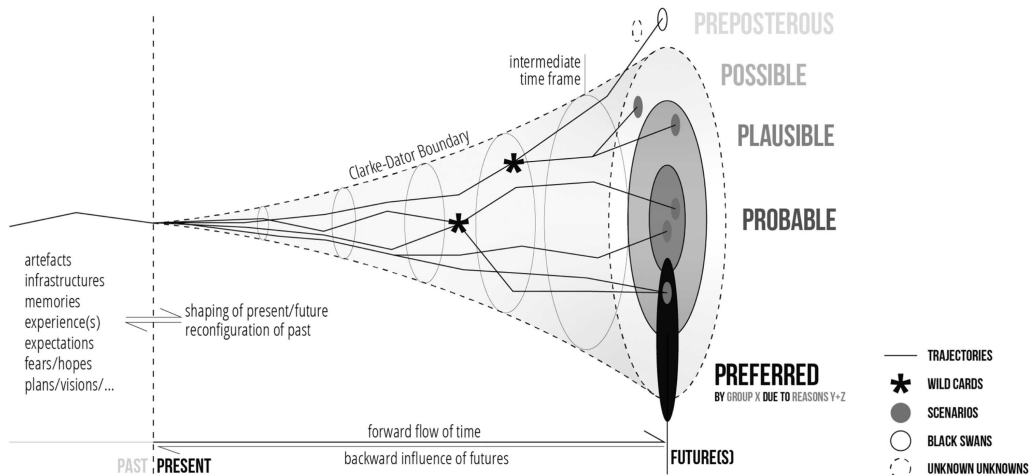


Figure 1: Illustration of the futures cone (Gall et al., 2022).

Categorising futures in this manner can help companies determine what future scenarios are worth investigating or working towards. An organisation working in an unstable environment will likely wish to work with an exploratory approach, to prepare for several possible developments. Therefore, they may wish to explore as many future scenarios as possible. In contrast, companies with a set goal, like gaining a set amount of market share, have already decided what future they wish to work towards. They will instead employ a normative approach, trying to find the correct course of action. The future could be illustrated as a set point within the preferred area of the Future Cone.

2.2 Designing for the Future

When designing for the future, there are various approaches. In academia, this is often done by creating prototypes and designs that help to create and explore a possible future through a form of “speculative ethnography”. The design space is often created by posing one key question from which the design is formed. The aim of the design project is often to generate debate and pose questions about societal developments and emerging technologies (Malpass, 2013). However, when designing for the future, companies aim to develop new products and strategies to survive in the future market. The following design work is generally more concerned with adapting and competing than solely posing questions. The different approaches can therefore be considered to have different starting points. In academic critical practices, the design is the starting point for describing the future, making it design-based (Malpass, 2013). In contrast, industrial design often utilises future scenarios as the starting point, therefore making the solution scenario-based.

A common basis of the modern design process is Design Thinking (see figure 2). It is an iterative, non-linear process that can be divided into five phases: Empathise, Define, Ideate, Prototype and Test. The process is meant to create an understanding of the users, challenge assumptions, redefine problems and find innovative solutions. It is a human-centred approach, primarily focused on understanding user needs and

the system in which the user and product exist (Interaction Design Foundation, 2016). The process is rooted in the present and the user needs that can be discerned today.

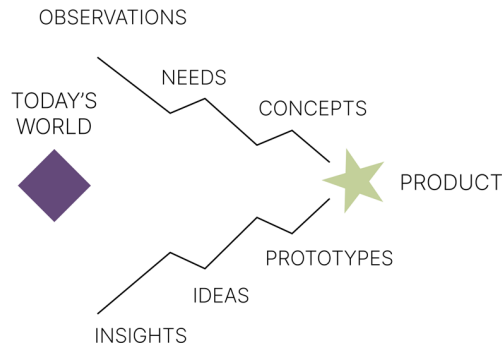


Figure 2: Illustration of a design process based on design thinking.

However, other methods of thought may also be applied in design work. Futures Thinking is a structured approach to envisioning a range of possible futures (see figure 3), often associated with futures studies (Boldrini, 2022). It is based on exploratory analysis and is not meant to create certain predictions, as all variables and dependencies shaping the world are impossible to fully account for (Forchheimer, 2022). Futures Thinking is based on divergent thinking, acknowledging uncertainties and seeking a variety of solutions and possible ways of navigating the future. This can help develop products and solutions that are more resilient to change and better adapted to a variety of possible conditions (Department of the Prime Minister and Cabinet [DPMC], n.d). It is usually applied when planning 10 or more years into the future (Boldrini, 2022).

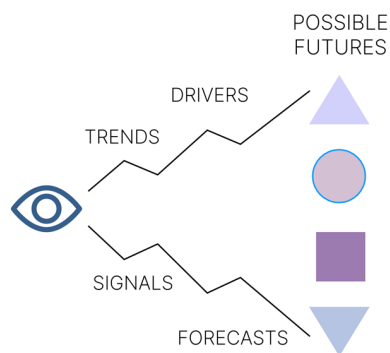


Figure 3: Illustration demonstrating the approach of Futures Thinking.

The approach includes gathering information from a diverse range of sources to then synthesise it into a collection of scenarios. For the resulting scenarios to be of value, they need to be grounded in present-day facts (Forchheimer, 2022). Therefore, Futures Thinking entails extensive collection of information to map a wide range

of trends and their drivers (Synario, n.d). The trends describe what trajectories may be discerned in current events. As famously stated by science-fiction author William Gibson: “The future is already here — it’s just not evenly distributed” (Forchheimer, 2022). By synthesising the gathered information, it is therefore possible to create plausible visions of the future. Moreover, the approach is based on a systems view of these trends. The research should not exclusively focus on factors that are immediately connected to the project. Macro factors that may influence international, domestic and organisational circumstances should also be included (DPMC, n.d). All trends and developments must be viewed as part of an intricate ecosystem (Boldrini, 2022).

The combined use of Futures Thinking and Design Thinking is becoming increasingly common. The first approach is used to identify future problems and the latter for creative problem-solving. By using Futures Thinking as a complement to Design Thinking, innovative solutions may be created that are better adapted to meet the demands of the future (Boldrini, 2022).

2.3 Types of Trends

When researching trends, it is necessary to differentiate them based on factors such as impact, scale and certainty. Some societal developments may continue their trajectory, while others cause counter-reactions. Moreover, their effects may vary greatly, both in terms of geographical spread and societal penetration. Megatrends are, according to the European and Policy Analysis System [ESPAS] (2019), trends that affect many different societal areas on a large scale, often globally. They are a combination of many smaller trends moving in the same direction and are more certain than individual trends (Petersen et al., 2022). Megatrends extend over long periods of time and, crucially, have a perceivable impact on the present (ESPAS, 2019). Because of this, their effects can clearly be observed and provide partial insights into a likely future. Climate change is an example of a megatrend; its effects have been long observable and it will continue to have further impacts. It includes trends such as increasingly frequent and severe weather events and disturbances in ecosystems. However, according to ESPAS (2019), the exact characteristics of megatrends are open to interpretation, as well as their effects. The precise nature of their impact is unknown. Despite this, they serve as a guide, narrowing down an infinite amount of possibilities to a tangible amount of possible futures (ESPAS, 2019).

Other trends may have a significant impact on the future but a higher degree of uncertainty; ESPAS (2019) calls these catalysts. These are generally faster-moving developments, causing more sudden and unpredictable effects. Catalysts can also accelerate or decelerate other catalysts and megatrends. Therefore, they must be considered when building future scenarios. Because catalysts appear faster, in contrast to slow-moving megatrends, they force people to take action faster. Consequently, they often take up much time and focus during trend analyses (ESPAS, 2019). One example of a catalyst is the outbreak of war. Conflicts may escalate quickly and unexpectedly, with sudden but enormous ramifications. Locally, it causes casualties

and damage to societal systems. On a global scale, it can cause disruptions in the global market.

2.4 Project Approach

The case is intended to contribute to Volvo Group’s innovation work. Their overarching goal is to explore new work methods. To achieve this, the aim was to create scenarios that can function as a basis for design, triggering creative thinking. This necessitates that these futures are markedly different from today’s world. Moreover, they should describe plausible or possible developments. Because both megatrends and catalysts were to be included in the scenario construction, the probability of different trajectories vary. However, while these futures must not necessarily fit into the category *preferred*, they must be reasonably conducive to Volvo’s business; there must be a variety of business opportunities to explore within them.

The focus did not lie in determining what exact course of development is most probable. This project was based on exploratory conjecture, aiming to describe a multitude of plausible futures within the set time frame. A Futures Thinking approach was adopted when researching trends and constructing scenarios. In order to build an intuitive understanding of possible future developments, information was gathered about a wide variety of societal and industry specific trends and analysed with a systems view, trying to understand their relationships. By utilising divergent thinking, the gathered information was then synthesised into scenarios.

The process used in this project fused the use of Futures Thinking and Design Thinking (see figure 4). The scenarios replaced the initial design stage aimed at investigating and mapping current user needs. The needs that could be discerned from the scenarios’ narratives served as a substitute. However, when the designs were later created, other elements of a Design Thinking process were used, ideating and developing possible solutions.

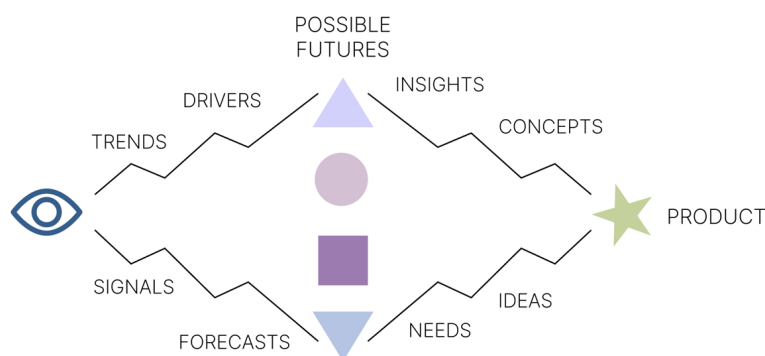


Figure 4: Illustration of the approach used in this project.

3

Methodology

In this chapter, the method for the project is presented. Firstly, the Method Selection presents the way in which the methodology was decided and constructed. The project is divided into three phases: Synthesising, Creation and Evaluation of method (illustrated in figure 5). The first phase, Synthesising Scenarios, was an iterative process of three activities: Understanding, Scenario Construction and Expert Input. The second phase, Conceptualisation, was an iterative process consisting of two activities: Ideation and Evaluation of Concepts. Finally, Evaluation of Methodology, presents an evaluation of the method based on several selected criteria.

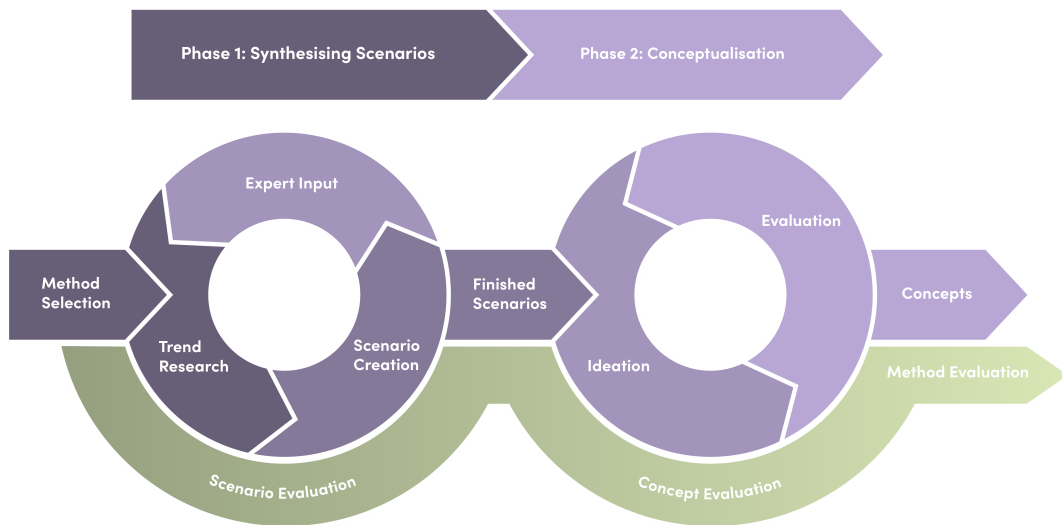


Figure 5: Illustration of the design process in this project.

3.1 Planning of Methodology

As the aim of this project was to evaluate whether the scenario creation method can form a strong basis for design, the project must not only create scenarios but also use them in an actual design process. To execute this, the project was divided into three main phases.

For Phase 1 (see section 3.2), methods supporting a Futures Thinking approach to was used to gather and creatively synthesise a wide range of information. This phase was a highly iterative process, combining research and scenario construction methods to continually create future predictions. Expert interviews were also conducted to gain additional insights and as a form of formative evaluation.

Phase 2 (see section 3.3) included testing the scenarios as a tool for design. This phase followed a traditional design approach, continuously ideating, developing and evaluating concepts. The aim was to test how well the scenarios spurred creativity and whether the resulting ideas and concepts generated ideas new to Volvo Group.

Finally, in Phase 3 (see section 3.4), a focus group of designers working at Volvo Group helped to evaluate the design concepts and process. Moreover, to evaluate the methodology, we reflected on our subjective experience of utilising the chosen methods and how they had supported the work during the project.

3.2 Phase 1: Synthesising Scenarios

Phase 1 consisted the three activities: Trend research, Scenario creation and Expert analysis. The output of each activity fed into the others, creating an iterative process. The purpose of this phase was to create scenarios in which to use in the next phase, Conceptualisation.

3.2.1 Trend Research

The first activity consisted of gathering information. A basic trend research method was selected from the book *Design Process and Method* (Wikberg-Nilsson et al., 2015). This simply entailed identifying trends and gathering information on a work board, in the form of images, article clippings and screenshots. For this the digital platform Mural was used. Finally, the trend research included looking for patterns and how trends are connected. To help us structure this work, we chose to do a PESTLE-analysis, categorising and mapping the relationships between the trends.

3.2.1.1 Data Gathering

In order to understand the industry of trailers, a market analysis was conducted by examining the websites and product ranges of competitors. The gathered information mainly described what practical solutions exist today and the various types of transport trailers are designed for. Some reading also went into technological developments within the industry. Moreover, Volvo Group provided some internal information, which consisted of some of their competitor research and user surveys. They also presented their analysis of some technological developments expected to affect the industry. In combination, all of the information helped to create a broad understanding of current technologies and solutions within the industry, as well as some possible future trajectories. The market analysis was then extensively used in the creation of scenarios and ideation activities.

The main type of data gathering consisted of researching trends. These were partly related to trucks and trailers, but most concerned larger societal developments. An initial focus was put on megatrends, as they are the most certain in terms of probability. Because of this, they formed a foundation for all scenarios. Once the megatrends had been identified, individual trends contributing to their development was researched. For example, for the megatrend *rapid technological development*, AI and automation was researched through internet resources and scientific articles. Reading about these smaller trends helped to form a more nuanced understanding of the megatrends' impacts on society. Additionally, impactful but uncertain trends, i.e. catalysts, were also considered during the research. Examples of these included potential groundbreaking technologies and rising political tensions and conflicts.

The research was done by thoroughly searching the internet for information. This included reading news articles, scientific papers, forecast reports and articles. Initially, focus was put on sources that the authors deemed important for any given industry or market. This provided information about many trends and their drivers simultaneously and therefore served as a basis for further research. Yes, the sentence is correct and clear. Furthermore, some trends recurred across several different sources, indicating that many authors ascribed importance to them and considered them likely to have a significant impact. Eventually, many articles and papers presented information that had already been encountered previously, indicating that a degree of saturation in the research had been reached.

A significant portion of this work was done using articles from the European Union and DHL's *Logistics Trend Radar 6.0* (n.d.), which presented prominent societal and logistics trends respectively. However, some trends were lifted directly from *Fyra framtider: Energisystemet efter 2020* [Four Futures: The Swedish energy system beyond 2020] (Swedish Energy Agency, 2016), as its scenarios are based on megatrends. However, these trends were then further researched. Moreover, ChatGPT was used in order to discover new information and areas to explore. While the information ChatGPT presented was judged not to be trustworthy, it allowed us to quickly discover further research areas. To do this, questions such as "What are the most important trends for logistics within the coming 15 years?" were asked.

3.2.1.2 Organising

All of the gathered data was put into and sorted in Mural, a digital work platform online. They were presented in the form of text and image extractions, summaries or headers. Additionally, the link to each source was included, allowing quick access to the original text for reference if needed.

Similar or related trends were then grouped together and categorised as either “Truck & trailer trends” or “General trends”. The Mural was used throughout the whole project as the main working space. Because of this, it was easy to look back upon previous work and get an overview of the collected information. This was helpful for planning and structuring the scenario building process.

After all trends were gathered in the Mural, a PESTLE analysis was made in order to structure and summarise the findings from the trend research. PESTLE stands for Political, Economic, Social, Technological, Legal and Environmental and is a strategic tool used for decision-making (Makos, n.d.). Coinciding or related trends were connected and a clear structure was achieved.

3.2.2 Scenario Creation

Having gathered a wide variety of trends, the next step was to use these to create scenarios. The trends were put in various combinations in order to explore how they might interact. For this, we selected the method “If this is true, what else is true?”.

To construct the scenarios the format used in the report *Four Futures* (Swedish Energy Agency, 2016) was utilised. Each scenario was described using a set of specific categories: community planning, lifestyle and living, industry, transport, politics and power supply and fuel.

Finally, we chose to create flow charts describing the logistic flows within each separate scenario. The purpose was to concretise the effects on the truck and trailer industry, thereby exploring the scenarios implications for our specific design case.

3.2.2.1 Trend collisions

Up until this point, all of the trends had been collected without analysing their combined effects. To explore this, a method called “*If this is true, what else is true?*” was used, which is a tool commonly used in improvisational theatre (Espiritu, 2016). The method is performed by first stating a fact about a hypothetical scenario, which is then followed up by asking what else could be true due to that fact. Consequently, after several iterations, a fleshed out scene can be created.

According to Espiritu (2016), this can also be applied to other areas, such as testing out business ideas in a rapidly changing world.

When using “*if this is true, what else is true?*” for the project, three trends were selected based on interest and put in a triple Venn diagram (see figure 6). The megatrends, however, were present in all scenarios. In the Venn diagram, each area represents a world in which one of the selected trends has an impact. The overlapping areas represent a world in which the effects of the trends take place simultaneously and interact. “*If this is true, what else is true?*” was used over several different iterations with different trends. To further nuance and vary the approach, some iterations included adding additional trends into the inferred “truths”. Eight iterations were done in total. Because many trends were related, several scenarios eventually became similar. Therefore, it was determined that the number of iterations was sufficient to thoroughly explore the gathered trends.

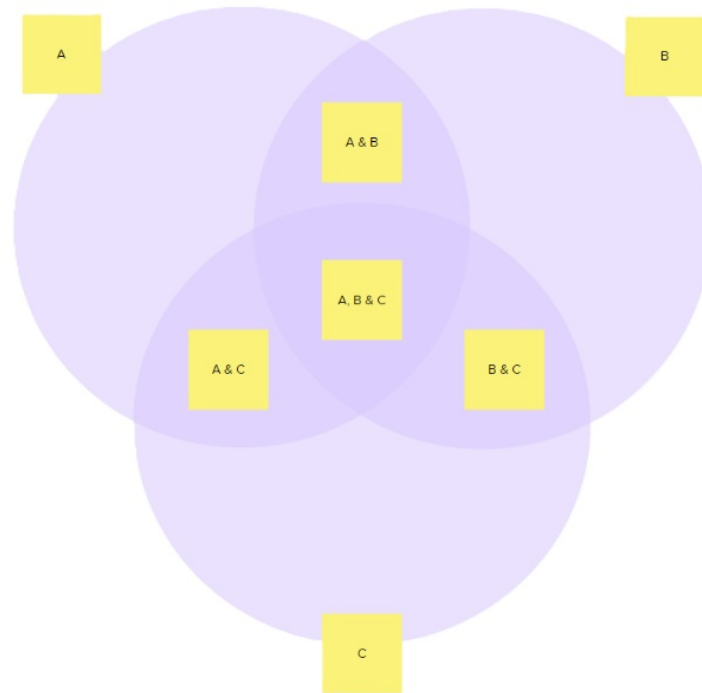


Figure 6: Illustration of a Venn diagram, as used in the method “*If this is true, what else is true?*”.

To exemplify the method, we can consider a world built by combining the three trends: autonomous vehicles, an ageing population and an increase in extreme weather. An ageing population might mean that the available workforce will decrease. However, if this effect is combined with the fact that the number of autonomous vehicles increases, the lack of workforce might not be a problem within logistics. If an ageing population is instead matched with extreme weather, there may be a greater need for efficient cooling and heating solutions, since the elderly are more severely affected by extreme temperatures (ESPAS, 2019).

3.2.2.2 Scenario Selection

The scenarios were evaluated through discussion, both within the group and with the company supervisors. During these discussions, their potential for spurring creativity, particularly for the design case, was considered. Some scenarios were found to be too uncondusive to Volvo Group’s business. For example, scenarios predicting a strong political radicalisation in society or unmanageable crises. Therefore, they were suspected to strongly limit the available design space. On this basis, they were discarded.

Since all megatrends needed to be accounted for in each scenario, several scenarios were not principally based on mutually exclusive assumptions, but rather on different points of emphasis. Therefore, they could technically exist simultaneously. However, they were examined to discern different parameters to categorise and construct the scenarios around. (Placing them in a coordinate system of parameters could have served to better illustrate their key differences.) It was found that the different points of emphasis could be characterised as different narrative themes. Because these themes were present in several scenarios, three were selected as a basis for developing three separate scenarios. The themes were described using guiding keywords, such as moderation or individualism, which described the most central values within each given scenario. The values were unique for each scenario and were separate from the key trends.

3.2.2.3 Scenario Description

Once the three scenarios had been roughly defined and selected, the next step was to develop them further. To form a more substantial basis for design, they needed to be expanded upon.

The assumptions generated during the “*If this is true, what else is true?*” exercise were written on notes in Mural. These were then organised within their respective scenarios and connected with lines to show their relationships. This way, a map of each scenario was created. To expand the world descriptions, adjacent trends were added to the networks. (For example, rising environmental awareness could be linked to emerging “green” technologies.) The same question, “*If this is true what else is true?*”, was posed for these added trends to build fuller, more substantial worlds.

The scenarios were then described using a format borrowed from *Fyra framtider: Energisystemet efter 2020* [Four Futures: The Swedish energy system beyond 2020] (2016) by the Swedish Energy Agency. In the report, future scenarios are described using six different categories: community planning, lifestyle and living, industry, transport, politics and power supply and fuel. By using these categories to describe each future, the aim was to create scenarios of equal quality that were consistent in

the type of information they provide. When writing these descriptions, the content was continually discussed and further questions were consequently raised. It was often found necessary to research related topics to create a nuanced understanding of various trends. For example, when discussing the future of globalism, further reading was needed about China's control of rare earth metals resources and their history of using export bans as a political tool. The knowledge gathered was synthesised in group discussions and contributed to building an intuitive sense of possible trajectories. In addition to this, the narrative themes in each scenario also served as a guide when writing about them in detail. These helped to organise what developments and trends were to be focused on in each respective scenario. Because one of the selected criteria of evaluation was consistency (as seen in section 3.4), it was determined that this was an appropriate format to imitate.

3.2.2.4 Impact on Logistics Chains

Having defined what society looked like in each scenario, the next step was to define the role of trucks and trailers. To illustrate this, a flow chart of the logistic chains in each scenario was created. The charts showed different delivery steps, going from farms, mills and mines to the final consumer. They also detailed different modes of transportation, important checkpoints and levels of automation. The purpose was to concretise what these worlds looked like and what practical differences the scenarios' logistic systems had. The systems had to be representative of the conditions and values present in each respective world.

3.2.3 Expert input

We chose to interview various experts in order to benefit from additional, informed perspectives. In all, eight people were interviewed during six interviews. (One was conducted with a team of three researchers.) Their opinions were used both for constructing and validating the scenarios. (A majority of the people who volunteered to be interviewed were researchers.) We chose to present our scenarios (in their unfinished state) as mediating tools. They were asked to evaluate the probability of each and add their personal insights on the subjects. The interviews were semi-structured in order to allow the interviewees to reflect freely and present whatever knowledge they deemed relevant. During the interviews, the experts shared their professional insights, describing both current industry problems and what future trajectories they found most likely. Their input was then compiled in an affinity diagram in order to organise the gathered information and investigate in which ways their opinions differed or coincided.

3.2.3.1 Interviews

The selected interviewees all worked in different professions related to transportation and trucks. One interviewee had experience designing logistical networks and another was a logistics researcher. One of the interviewees had long experience of

working at a trucking central. Another interview was conducted with a manager at the Port of Gothenburg. Finally, a group discussion was conducted with researchers in the fields of automation and telematics. (Telematics refers to the integration of telecommunications and informatics, where one or more devices share information [telematics.com, n.d.]

The interview questions mostly revolved around technologies, administration and trends within their respective expertise. Thus, each interview was tailored towards each expert. Additionally, the previously created scenarios were presented with a short summary and the interviewees were asked to evaluate them in terms of probability and how they could affect their respective industry. Notes were taken during each interview, and in most cases, voice recordings were also made. This facilitated the transcription of each interview, providing a foundation for further analysis.

3.2.3.2 Affinity Diagram

To organise the transcribed information from the expert interviews, an affinity diagram was made (see figure 7). The aim was to identify similarities and themes in the interviewees statements.

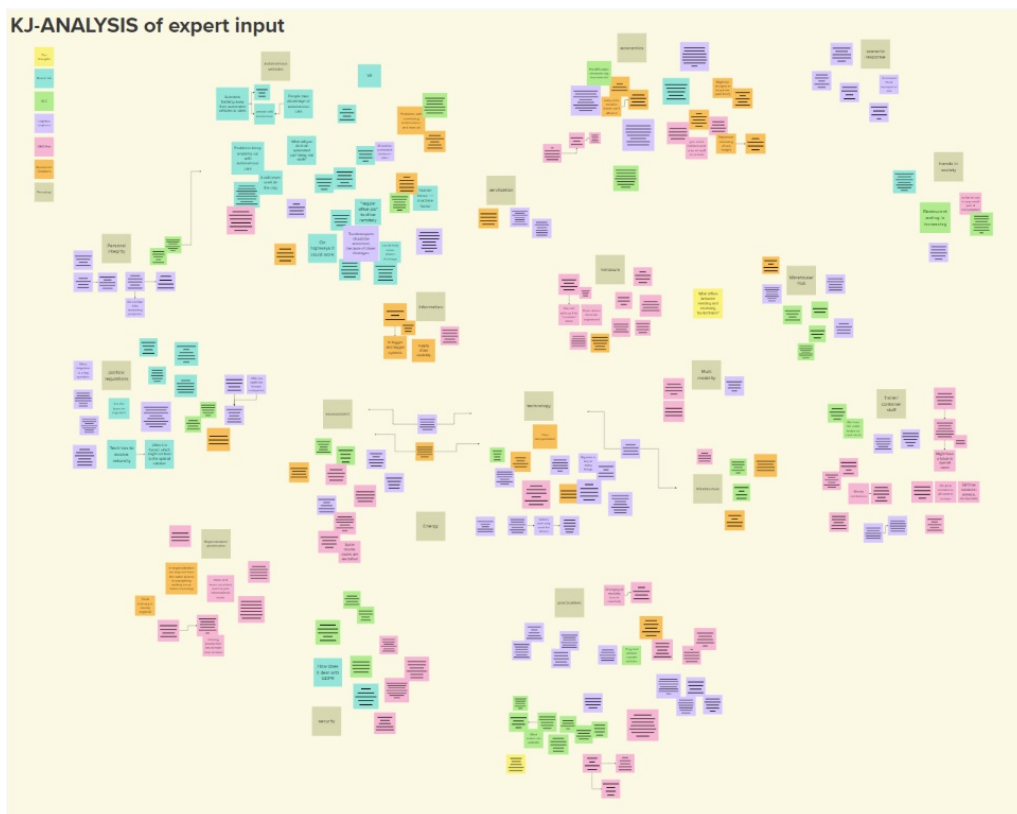


Figure 7: The affinity diagram in Mural.

An affinity diagram, also known as KJ-analysis, is a sorting method in which statements are organised in groups based on thematic similarities (Raymond, 1997). This is often done using sticky notes. (In this case it was done digitally via the software Mural.) The notes were assigned different colours based on who had made the statement to preserve the distinct perspectives of each expert. Additionally, notes summarising common points between the different interviews were added.

The themes that emerged in the affinity diagram primarily focused on specific trends, such as autonomous vehicles and globalisation. Various locations in logistic chains, such as harbours and warehouses, were also discussed. These subjects were then organised in clusters based on their similarities. For example, information about *warehouses* was grouped near *harbour*, and *politics* was grouped near *globalisation*. This clustering created a clear structure of the most significant observations, which could then be utilised for scenario iteration and, ultimately, ideation.

3.2.3.3 Iteration of Scenarios

Throughout the interviewing phase, the scenarios were continually revised. Some input led us to rewrite certain aspects and others to further expand the world building. New topics discussed during the interviews led to further questions. One example is the decision to consider sea freight in the scenarios, which was not initially the case.

3.3 Phase 2: Conceptualisation

Like the previous phase, Phase 2 was an iterative process, which involved the activities Ideation and Evaluation of Concepts. The purpose of this phase was to test the scenarios as a basis for design by creating concepts.

3.3.1 Ideation

Once the scenarios had been constructed, they would serve as a basis for concept ideation. This activity started with an initial, wide-scope exploration, where different solution spaces from the scenarios were explored. The most promising opportunity area was then picked for further ideation. Finally, two concepts were made.

3.3.1.1 Opportunity Exploration

The constructed world within each scenario served as a basis for brainstorming. The aim was to identify what new types of products would suit each respective world, specifically related to trucks and trailers. The cultural, technological, and political developments described enabled brainstorming of potential needs and challenges. Various markets were considered, including reverse logistics, where purchased products are returned to the distributor or manufacturer for recycling, repair, recovery,

or disposal (Repsol, n.d.). Other markets considered were long-haul, i.e. long distance transport, and last-mile deliveries (meaning the last leg of transportation). To further define user needs and possible opportunity areas within last-mile deliveries, an additional flow charts was made to illustrate them in greater detail.

The brainstorming was conducted in several sessions, each with a focus on a specific scenario. A variety of ideas were created and presented to the supervisors at Volvo Group. This was to get input for further ideation and hear what concepts could suit Volvo's business. However, during the discussion, one opportunity area was found to be of particular interest because of the multiple values a solution could potentially provide to customers. Because of this, as well as time constraints, this idea was chosen as a focus for further conceptualisation.

3.3.1.2 Creating Concepts

The main methods used to develop concepts were brainstorming and brain drawing. In addition to this, other types of products and solutions were used as sources of inspiration. For example, historical solutions for storing cargo on ships were briefly researched.

The work was focused on deciding what functions to include and how different components should interact. Some suggestions on specific mechanical solutions were also made. However, truly specifying the technical solutions would need much further research and testing. Therefore, emphasis was instead placed on describing the intended effects and functions of the product.

As the chosen opportunity area was quite closely tied to one specific scenario, some time was also spent exploring how it could be better adapted to the others. Consequently, a second concept was created, partly inspired by the first. This concept was then ideated on in the same manner, determining its functions.

3.3.2 Evaluation of Concepts

Throughout the project, our supervisors at Volvo Group were continuously consulted during regular meetings. They helped to direct the work efforts based on their professional knowledge and company insights. Ideas were evaluated in terms of their relevance to Volvo's Group's business and potential market value.

Once the final concepts had been chosen and developed, they were evaluated by a focus group of five designers at Volvo Group, as well as our supervisors and a patent engineer. The purpose was to receive feedback on both our method and concepts to discover potential improvements, opportunities, problems and points of interest.

The session was structured around different points of discussion. First, the concepts were presented and discussed in isolation. The participants were asked to consider each concept in terms of feasibility, viability and desirability. After this, a short

summary of our scenarios was presented. By doing this, the concepts could be put into their context. Moreover, the group was asked to quickly ideate ways to better adapt the concepts to each scenario.

The focus group participants were then asked to consider the next steps in developing the concepts. This was to evaluate how well the method and concepts would fit into a complete product development process. Lastly, the methodology of the project as a whole was evaluated.

3.4 Phase 3: Evaluation of Methodology

The final part of the project involved evaluating the scenario construction methods, as well as addressing the research question: “Will the chosen method of scenario building provide a useful basis for design?”. As Volvo Group provided the design case, one important factor was to determine whether the methodology or the resulting scenarios could be of use to the company. Furthermore, the quality of the result also needed to be assessed. To evaluate this, a set of criteria was selected, as listed in Table 1. Another criteria was set to evaluate the methodology, namely that it should have supported our work process.

In order to evaluate and investigate these factors, several methods were used. Firstly, the expert interviews we conducted during the project were a form of formative evaluation. The interviewees were asked to judge the probability of each scenario, discuss the subjects raised and add their own insights and predictions. Their reactions and thoughts were used to gauge the quality of the scenarios as they were being formed.

In a similar manner, the supervisors at Volvo Group were continually consulted during the project. Therefore, their insights and feedback also became part of a continual formative evaluation during the ideation phase. Moreover, later in the project, the focus group from Volvo provided feedback on the scenarios, concepts, and insights regarding our design process.

Lastly, to further evaluate the methodology, we reflected within the our group on our subjective experience of using the selected methods. For example, these discussions involved assessing how certain methods aided our thought processes. Additionally, consideration was given to whether the scenarios effectively sparked ideas and encouraged creativity during the ideation sessions.

Criteria	Description
Plausibility	The scenario should be plausible, meaning that it should be able to realistically happen (European Foresight Platform [EFP], n.d.).
Consistency	The scenario should be internally consistent, meaning that the set rules and logic in the world should not be contradictory (EFP, n.d.).
Comprehensibility	The scenario should be detailed enough to give a clear understanding for the reader. It should not be so complex as to become incomprehensible (Kosow & Gaßner, 2008).
Distinctness	The scenarios should be different enough to allow for readers to interpret and compare them as different futures (Kosow & Gaßner, 2008).
Degree of Integration	The scenario should be sufficiently vertically integrated, meaning detailed enough within each described topic area. It should also be sufficiently horizontally integrated, meaning the interaction of different topic areas (Kosow & Gaßner, 2008).
Time and Effort Involved	While scenario creation often requires a significant amount of time, typically months, a longer period may be justified if the result is of high quality. The time spent is usually proportional to the level of integration (Kosow & Gaßner, 2008).

Table 1: Criteria to evaluate the scenarios.

4

Case Output

In this chapter, the different results gathered throughout the project are presented. This includes Identified Trends, Expert Input, Scenarios, Design and Evaluation. The Identified Trends describes some of the most impactful trends that formed the basis of the scenarios. This is to illustrate the most central information utilised during Phase 1. Under Expert Input, the most significant insights from the interviewed experts are presented. Under Scenarios, each scenario is presented and described using the categories of the Four Futures report. Under Design, the two created concepts are described and under Evaluation, evaluations of both the concepts are presented.

4.1 Identified Trends

Below are the identified trends that have had the most significant influence on the creation of the scenarios. They were considered to have the highest impact on the future of society and truck & trailer industry within the coming 15 years. These are divided into two groups, megatrends and catalysts, as seen in figure 8.

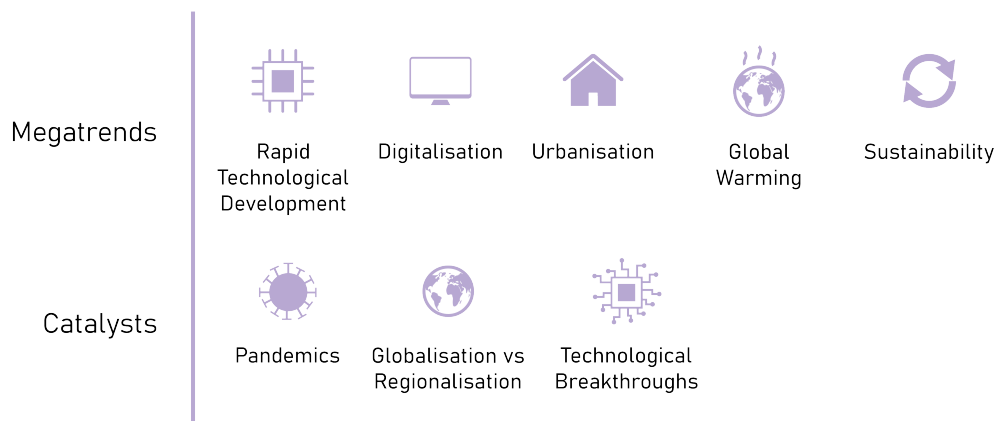


Figure 8: Illustration showing all of the selected megatrends and catalysts

4.1.1 Megatrends

The megatrends have a high degree of certainty and impact, and are therefore present, to some degree, in every scenario.

4.1.1.1 Rapid Technological Development

Throughout history, humanity has always been inventive and developed new technologies. However, in recent history, technological development has continued at an escalating pace (Roser, 2023).

An area currently going through rapid development is robotics and automation. Automation has already altered many industries and will likely continue to revolutionise how they operate (Petersen et al., 2022). Mundane and repetitive tasks, which used to be performed by humans, are now being performed by robots that can work much faster and cheaper. The advancements in AI technology also allows further development in autonomous robots and vehicles. This may further revolutionise the logistics and transportation industry (Petersen et al., 2022).

Technologies like AI have also introduced a new dimension to automation by performing tasks that closely mimic human cognitive abilities (Petersen et al., 2022). This includes examples such as writing text, interacting with human beings and making conclusions based on complex data input. This will likely affect society in many ways, facilitating many daily tasks in our lives. However, it will also disrupt the current job market, changing what types of work are available (ESPAS, 2019). Many current jobs will probably disappear, while entirely professions or tasks emerge.

Technology even offers the possibility of manipulating genetics. With biotechnology we can alter our bodies and fight diseases, possibly eliminating the natural, biological limitations of our bodies (Petersen et al., 2022). Further, it also allows us to modify crops and animals to better suit our dietary and environmental needs. Moreover, new and better materials are constantly being developed, helping us push the limits in areas such as computer science and architecture (Petersen et al., 2022).

4.1.1.2 Digitalisation

The world is growing ever more connected. The percentage of the global population with access to mobile connection and broadband is estimated to reach 75% and 60% respectively by 2030 (ESPAS, 2019). Not only are more people gaining this access, but more devices are becoming connected as well. Today, there are an estimated 25 to 50 billion devices around the world that are connected to the internet, and this number will likely continue to grow in the future (Petersen et al., 2022). These devices are not only smartphones but also other products, such as vehicles, housewares and robots. These different devices communicate with each other through the internet, allowing for a quick and efficient flow of information. This phenomenon is known as the Internet of Things or IoT (Petersen et al., 2022).

IoT enables machines to be controlled remotely and different devices to cooperate, which in turn enables more tasks to be automated. Furthermore, this creates data that can be gathered and used, helping decision making in both organisational and state levels by its high accuracy. As the access to the internet increases, many business opportunities follow. Services that could only be done physically before, such as grocery shopping, can now be done completely online. Further, more and more people spend considerable time online to catch up on news, socialise or be entertained.

While digitalisation creates numerous opportunities, it also has negative aspects. One such problem is the vulnerability towards cyber attacks. With increasingly connected technology and societal functions becoming dependent on the internet, cyber attacks pose a significant threat towards organisations and society as a whole. According to ESPAS (2019) connectivity multiplies human behaviour, whether it's good or bad. This can be exemplified with social media and the internet. They make it easy to engage with other people online and satisfies the human desire for connection and entertainment, even leading to addiction in some cases (Hilliard, 2024). It also dramatically boosts spread of misinformation. In fact, some studies suggest that misinformation spreads much more rapidly than correct information since it is often more shocking and novel. Therefore, it attracts attention and creates engagement (Kleinman, 2018).

4.1.1.3 Urbanisation

Large scale urbanisation has been present in Europe and North America since the early 20th century (ESPAS, 2019). This is expected to continue and even increase exponentially during the course of the 21st century, especially in the global south (Petersen et al., 2022). Existing megacities will continue to grow, and new ones will likely emerge. However, according to ESPAS (2019) the majority of urbanisation in the near future will happen in smaller cities (those with less than 1 million inhabitants). Because of this, despite the concentration that comes with urbanisation, populations will be spread out.

Urbanisation has both positive and negative aspects. On the positive side, cities create increased productivity locally, foster economic growth and give people easier access to societal functions (Petersen et al., 2022). They also serve as a concentration of social, cultural and commercial activities. Thus, companies that wish to compete have to be present in those high-density areas and provide products and transportation solutions tailored for the city environment. On the negative side however, urbanisation is associated with an increase in crime. When the population moves into cities, it entails changes in social structures with less informal social control, especially during rapid urban growth when different social groups are less likely to integrate (Malik, 2016). The concentration of the population in cities gives more opportunity for crime as well as anonymity among its citizens, lowering the chances of arrest. Moreover, rapid urbanisation, unable to meet rising demands for housing and work, can create civil unrest. Moreover, cities also contribute to worse

living conditions as air pollution, which could contribute to respiratory and heart diseases among the population (Swinney, 2019). While cities do provide higher resource efficiency compared to urban living, cities will account for about 70% of the world emissions in 2030 (ESPAS, 2019). This makes them an important factor to consider when building a greener world.

4.1.1.4 Global Warming

By 2030 the world will reach an average of 1.5 °C warmer than pre-industrial times (The Intergovernmental Panel on Climate Change, 2018). Climate change and its effects are expected to further threaten natural ecosystems and biodiversity, and the risks of these effects being pervasive and irreversible are likely to increase. Global food security will decrease (European Environment Agency [EEA], 2020) as well as secure access to fresh water (World Wildlife Fund, n.d). By 2030 nearly half the world's population is expected to face severe water stress (PwC, 2022). In addition to this, the rising global population further exacerbates the issue of depleting resources (EEA, 2020).

Longer and more frequent heat waves will negatively affect people's health, especially in vulnerable groups like children, the elderly, outdoor workers and poor people (Joint Economic Committee, 2023). The healthcare costs of heat-related illness will likely rise (Woolf et al., 2023) and combating extreme weather is expected to continue to cause enormous expenses (ESPAS, 2019). High temperatures will also decrease production, especially for physically demanding professions (Johnston, 2016). Moreover, extreme weather will likely damage and disrupt both production and transportation of goods, which in turn increases prices and creates supply chain disruptions (PwC, 2022). Because of this, economic growth is expected to slow down (EEA, 2020).

To reduce the risks of irreversible ecological damage, the EEA states that climate change mitigation is the only option. What measures are taken now and in the coming decades will determine the climate's development (2020). However, societies are not undergoing sufficient change to become sustainable, and the risk of uncontrollable climate change increases (ESPAS, 2019).

4.1.1.5 Sustainability

As the effects of climate change become increasingly evident, global concern for ecological sustainability is rising. In 2015, all United Nations member states adopted the 17 Sustainable Development Goals (SDGs), which call on all nations to combat climate change, eradicate poverty, and address social injustice (United Nations [UN], n.d.). An example of these goals is for the world to have affordable and clean energy. Governments worldwide continue to invest in sustainable energy (International Energy Agency, 2023), prompting many industries to shift towards sustainable energy sources like wind and solar power (Petersen et al., 2022). Additionally, efforts are being made to advance green technologies, improve resource efficiency, and promote sharing and circular economies (UN, 2023). These initiatives aim to reduce the en-

environmental impact of products by extending their lifespan and minimising energy consumption.

There has been a substantial rise in environmental regulations across nations, resulting in a 38-fold increase since 1972 (United Nations Environmental Program [UNEP], 2019). However, despite this, environmental laws often fail to be enforced. UNEP states that the reason is often a lack of cohesive strategy unifying different initiatives. In consequence, the laws are inconsistently enforced and compliance often becomes low to non-existent (UNEP, 2019).

Consumer demand for sustainable products is rising. In recent years, “ethical consumption” has become a widespread trend. Consumers increasingly make purchasing decisions based on companies’ proclaimed values, favouring those that are perceived to be ethical and sustainable (Johnson, 2023). This trend is global, both in rich and developing countries, where many consumers want companies to commit to protecting the environment (Martins, 2024). However, the prevalence of greenwashing creates distrust among consumers globally, with over 50% believing that brands across all industries mislead their customers with their sustainability claims (Kakkad, 2023). The UN names greenwashing as a significant obstacle to combating climate change, as it promotes false solutions, obscuring and delaying effective measures (UN, n.d).

However, it may become increasingly difficult to benefit from false sustainability claims. Earlier this year, the European Parliament adopted new directives intended to combat greenwashing by forcing companies to substantiate and verify their claims (Simmons & Simmons, 2024). In the long term, due to shifting values and increasingly strict regulations, companies may have to adapt and become sustainable to remain competitive.

4.1.2 Catalysts

The catalysts are trends with a high degree of impact on the world, but simultaneously with a high degree of uncertainty. Their presence and influence in the scenarios vary, which contributes to creating distinction between them.

4.1.2.1 Pandemics

The outbreak of COVID-19 in 2020 posed unprecedented challenges across the world. During the pandemic, many human lives were lost and an enormous strain was put on healthcare and financial systems. Millions of enterprises struggled to maintain their business and particularly low income countries and workers suffered economically (World Health Organization [WHO], 2020). The need to suddenly restrict human interaction forced many organisations to rapidly adapt to remote work (Marcus, 2022). This catalyst event therefore accelerated the pace of digitalisation in society (Petersen, 2020).

The world of transport and logistics was greatly affected. Disruptions in China's manufacturing caused domino effects throughout the global supply chain. Major industries around the world, such as automotive, electronics and pharmaceuticals, were impacted (Twinn et al., 2020). Confinement measures, trade restrictions and border closures have laid bare vulnerabilities in domestic and international supply chains (WHO, 2020).

While the COVID-19 pandemic was unprecedented, similar outbreaks will likely occur in the future. The effects of climate change are expected to cause the spread of more pandemics. The loss of biodiversity causes the proportion and interaction between different species to change as the system's ability to regulate itself is disrupted. This increases the spread of pathogens, which can spill over and infect livestock and humans, causing epidemics (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2023). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES] warns that future pandemics will occur more often, spread more rapidly, have higher mortality rates and damage the economy more severely unless preventative measures are taken. This would entail measures to preserve ecosystems and stop over-exploitation of natural resources. Further, IPBES calls for international cooperation and organisation to prevent new pandemics (UNESCO, 2023).

4.1.2.2 Globalisation vs Regionalisation

As the world becomes more and more connected, countries undeniably get more intertwined. No matter the distance, people from different nations can share views and opinions over the internet. This is not only true in the digital world; thanks to increasing migration and travel, physical distances no longer form a barrier as they have done historically. These developments lead to growing cultural and ethnic pluralism (Petersen et al., 2022). Moreover, international trade has become an important factor in the global economy. Despite events such as the pandemics, which heavily restricted travel and global transports, Petersen et al. (2022) argues that there are no signs of globalisation slowing down.

Despite the fact that globalisation has increased over a long period of time, its continuance is not certain. ESPAS (2019) argues that the future of global interconnectivity is unclear. There are several factors that suggest an opposite development. Rising geopolitical tension has led many observers to expect a shift from globalisation to regionalisation (Altman & Bastian, 2023). Galani (2022) lists several events illustrating this shift, such as Brexit and the US-China trade. Moreover, Russia's invasion of Ukraine has spurred many countries to increase their degree of self sufficiency (Galani, 2022). The war initiated by Russia towards Ukraine has caused massive sanctions to be made towards Russia (European Commission, 2024), greatly limiting other nations trade with the country and consequently disrupting supply chains. Petersen (n.d) predicts that a shift in global value chains will occur, in which risks and conflicts will increasingly influence economic and political decisions. This in turn may lead to a decreased emphasis on efficiency and cost minimisation, instead prioritising national sovereignty. This in turn can lead to isolated spheres of

differing technological development, making innovation ability an important factor in the power dynamics between nations.

An example of this type of innovation race between countries is the trade war between the US and China (Petersen, n.d). Between 2018 and 2019 the countries imposed several tariffs between them (Bown & Wang, 2023). A more recent example of this is the US deciding to limit exports of high end computer chips to China (Nellis, 2023) in order to limit their development of AI. China, on the other hand, is the world's primary producer of rare earth metals, which is a group of metals vital for advanced electronics (Durfee & Slodkowski, 2023). The country has previously used their control of this resource as a tool to put pressure on other countries during political conflicts (He, 2023).

These rising trade conflicts contribute to a rise in protectionism, countries seek to protect and limit sharing of their most important resources. This would also cause a disruption of global supply chains and conducting worldwide business will be much harder (PwC, 2022). All in all, these factors suggest that globalisation may halt. Several trends indicate that the world may grow more regionalised and protectionistic. However, this possible development is highly uncertain. While some expect the world to de-globalise, others firmly expect globalisation to continue. For example, while there may be political will to decrease dependencies, some natural resources are concentrated in certain parts of the world. Our dependency of these materials will therefore force countries to remain interdependent to some degree (White, 2023). Depending on which direction these developments take, it will impact societies across the world in almost every aspect.

4.1.2.3 Technological Breakthroughs

That technological development will continue at a rapid pace is widely accepted as inevitable. However, what specific innovations will be made and what consequences they will have on society remain uncertain. Similarly, the exact dates any technological breakthroughs will be made is highly uncertain. Technological inventions do, however, have the potential profoundly influence society and alter the course of the world. It is the combination of this uncertainty and high potential impact, that make makes certain technological breakthroughs catalysts. Past examples of important technological breakthroughs include the invention of the printing press, steam engine and the computer (Gregersen, n.d.). A more recent example is arguably AI, which is continuously getting more advanced and incorporated in society.

Another emerging technology with a potential to massively impact the world is autonomous vehicles. Should this technology become widely adopted it has implications for private individuals as well as many industries. Such vehicles could help to create significantly more efficient transportation networks. Autonomic systems and autonomous vehicles have the ability to operate around the clock, without need for breaks, at lower costs (Petersen et al., 2022). Furthermore, there is a considerable shortage of drivers in Europe. This is both due to an increased demand for transportation and a lack of new labour force. (Unattractive working conditions,

causes the ageing driver population to shrink.) In fact, in 2026 about 30% of the workforce is due to retire. Retirement rates are expected to triple the rate of drivers entering the profession (International Road Transport Union, 2022). Autonomous vehicles have the potential to help alleviate or even fully solve this problem. However, achieving this still requires considerable progress. The level of automation is generally described using a scale of 1- 5 (Kosuru & Venkitaraman, 2023). The maximum level 5, requires zero human interference and can adapt to new situations. Despite the many efforts to achieve this level in autonomous vehicles, it is uncertain when it may become a reality. Today, there are vehicles with a relatively high autonomous level. According to Kosuru and Venkitaraman (2023) there are solutions that have reached level 4, meaning that it can drive with minimal human interference. These are, however, only used in very specific and limited areas due to legislation and infrastructure limitations.

Another possible technological breakthrough, which would have an enormous societal impact, is nuclear fusion. Fusion involves the process of combining nuclei, in order to release a large amount of energy. This has massive potential as an energy source as it would have four times the fuel efficiency compared to fission (Barbarino, 2023). Furthermore, the fuel is clean and readily accessible. Although the technology is far from being implemented, researchers have managed to fuse nuclei in experiments with a net positive energy gain (Barbarino, 2023). While the future of this technology is largely dependent on global collaborations, according to Barbarino (2023), some estimations state that a functional fusion power plant could potentially be built by 2050.

4.1.3 Influence on Scenarios

All of the above mentioned trends, in addition to more specific trends, laid the groundwork for scenario creation. The megatrends, due to their relative certainty, were present in all the scenarios. However, how their exact impact on future society is uncertain. Thus, they can be interpreted in a number of different ways. An example of this could be the trend of digitalisation. One can speculate on whether it will cause a reduction in the production of physical goods, as servitization and digital products increase, or conversely, whether it will lead to more physical products being produced because of the ease of online ordering. The answer could largely depend on the context. For this reason, the method “if this is true, what else is true?” was useful when generating the scenarios. By combining different trends each time, the surrounding context would change, in turn changing the character of each trend as they interacted.

Furthermore, the megatrends were emphasised to a varying degree in the scenarios. For example, while Sustainability had an effect on society in all scenarios, its influence varied. In one scenario, it was highly influential, extensively affecting political decisions and industries. In another, it was a secondary focus in society. Instead technological innovation and consumerism was central.

Finally, another differentiating factor were the catalysts. While the megatrends were present in all, the catalysts were used in a more binary way; they either occurred or they did not. Since these trends have a large potential impact, they helped to provide clear identities for two of the scenarios (see section 4.3.2 & 4.3.3). For example, the issue of whether the world will become increasingly globalised or regionalised present two vastly different potential futures for global relations.

4.2 Expert Input

Throughout the first phase, several semi-structured interviews with various experts were held. The scenarios were used as mediating tools to access their perspectives on the trends being researched. In this way, the interviews functioned as formative evaluation to the scenarios. The experts provided their own perspectives and opinions regarding the state of current and future logistics systems. Their input led to certain subjects being further researched.

An example of this was the logistics researcher, who introduced the idea of including sea freight in the scenarios, since it is often more environmentally friendly than road transport. This led to the Port of Gothenburg being contacted in order to explore the world of sea freight. Similarly, when speaking to the logistics engineer, train transport was much discussed. These different modalities (meaning different modes of transportation), although separate from the focus of truck transports, provided another dimension to the logistics systems in the scenarios. Focusing more on how other modalities were used also helped to differentiate the scenarios. Ultimately, the inclusion of boat or train freight did not directly influence the final concepts, but did have a large impact on ideas and concepts created during the ideation activities. An example of this was the ideas developed around multimodal container transport.

Another topic the expert interviews gave valuable input on was the question of globalisation versus regionalisation. A continued globalisation seemed like the most likely trajectory to most experts. The manager at the Port of Gothenburg emphasised how dependent almost all industries are on material imports and manufacturing facilities in other countries. (Many products travel back and forth between several countries during production.) While he acknowledged the existence of initiatives to reshore industries, he believed no significant changes were likely to happen within the foreseeable future. However, according to most of the interviewed experts, regionalisation did not seem out of the question. They thought recent world events, such as the US-China trade war and the Russian invasion of Ukraine, indicated the possibility of such a development. Meanwhile, they all agreed that the consequences of decreased international trade would be enormous. Several experts mentioned the world's reliance on rare earth metals from China as a particularly critical issue, with some asserting that complete separation would be impossible. However, one expert explained that initiatives to develop new substitute materials exist to eliminate this dependence.

The future of technology was a major topic of discussion with all of the experts. Both the logistics engineer and the logistics researcher provided information regarding the automation of logistics chains, particularly in warehouses. These serve as an important link in organising and speeding up the delivery processes. Because warehouses are closed off spaces, it makes them an ideal place for autonomous robots to work. Moreover, warehouse work involves many tasks that are tedious and repetitive for humans. On the other hand, autonomous vehicles in less restricted areas, such as on public roads, was a split topic among the experts. While the general consensus was that autonomous vehicles can and will likely be a large part of future long-haul transport, its role in urban areas was less certain. The telematics and automation researchers were highly sceptical of using autonomous vehicles in cities. They thought too many problems have been proven to arise in such environments. One example being the issue of liability in the case of accidents. Moreover, they explained that tests have shown that people are far too likely not to respect traffic rules if they know the vehicle can't run them over. "People would just step out into the street and walk in front of them" one participant stated. These discussions provided the project group with a more nuanced understanding of the subject and helped to set the appropriate level of autonomy within each scenario.

The group discussion with the telematics and automation researchers also touched on the issue of cybersecurity in autonomous vehicles and similar technologies. Due to their connection to the cloud, these vehicles are susceptible to hacking, potentially posing significant security risks. The relevance of this issue was underscored during the interview at the trucking centre. They revealed that they had recently experienced a cyberattack, which forced them to revert to analog methods, such as using pen and paper to register the goods they handled. Thanks to these discussions, cybersecurity ultimately played a large role in one of our scenarios (see 4.3.3). Here, rising conflicts increase the threat of cyberattacks and thus more analogue options are preferred. The problem of cybersecurity had a significant impact on the ideation activities, as a rising need for analogue options provided a different perspective on possible future developments. In the end, this would play a central role in one of our concepts (see 4.4.2).

While interviewing the experts, the subjects of climate change and sustainability were also discussed. Overall, they thought these were extremely pervasive issues that significantly affect their industries. For example, the trucking centre representative explained that the increasing prevalence of rapid weather shifts affects their ability to carry out orders; the sudden changes in road conditions can completely halt transportation. As many of their deliveries are due to critical service facilities, such as hospitals and retirement homes, this development poses a severe threat, not only to their business but also to critical societal functions. In turn, this issue provided inspiration for both the scenarios and ideation activities as a problem that needed solving.

Another related topic discussed was government regulations, particularly those pertaining to environmental issues. Several of the experts mentioned the extensive

efforts that the EU puts into creating and enforcing regulations. According to the telematics and automation experts, these regulations are not always effective and can be circumvented. One participant thought they were often too prescriptive, locking companies to specific technological solutions. However, they thought that regulations were extremely important in shaping societal developments and were necessary to force companies to take action. Consequently, this dynamic was central to one of our scenarios (see 4.3.1), depicting a future where society achieves greater sustainability largely due to harsh regulatory measures.

One additional contribution of the expert interviews was their insights into the practicalities in different parts of logistics networks. This information helped to create more realistic flow charts within the scenarios and ultimately helped the design work during the creation phase.

4.3 Scenarios

In this section, the three scenarios Green Future, High-tech and Lonely Planet are presented. Each is described using the parameters: community planning, lifestyle and living, industry, transport, politics and power supply and fuel. Each scenario share the megatrends as a basis, however they have different interpretations and points of emphasis. Additionally, the catalyst of regionalisation, or continued globalisation, has a more central role in High-tech and Lonely Planet. The main differences of the scenarios are presented below in figure 9.




	 Green Future	 High-tech	 Lonely Planet
Main focus	Sustainable change	Technological growth	Resilience and frugality
Economic growth	Medium to low	High	Low
Technology	Medium	High	Low
Sustainability	High	Medium to low	Medium
World relations	Same as today	Globalisation	Regionalisation
Logistics intensity	Low	High	Medium to low
Trucks role	Deliveries to places where trains and boats cannot reach	Used extensively with high efficiency	Used for large portion of transports
Truck autonomy level	Semi-autonomous to assist driving	Highly autonomous in most areas except cities	Analogue systems with human driver
Most important truck metric	Energy usage	Time	Security and resource efficiency

Figure 9: Illustration highlighting the main differences between the scenarios.

4.3.1 Green Future

Green future is a world where focus has shifted from rapid development and consumerism to a slower and more sustainability focused world. Although technological advancement is still present, priorities have shifted towards solutions that promote circularity, shared use and resource efficiency. This is partly due to a cultural shift in public opinion regarding sustainability, but mostly due to governmental regulations that forcibly save the planet.

Key trends: Global Warming, Sustainability, Urbanisation

Keywords: Moderation, Regulations, Circularity, Modularity, Slow-paced

Lifestyle and Living

Values in society have shifted heavily towards sustainable living. (Excessive consumption is taboo.) In general, people try to repair broken items rather than purchasing new ones. Many people have learnt to mend clothes and textiles and general proficiency in handcrafts has increased. Furthermore, repair services have exploded in popularity. Any complex mending is done by professionals who use a mix of old skill sets and modern, technological tools. Fashion varies more in terms of making alterations to clothes, special types of stitching or small add-on details.

Spending money on experiences is prioritised over physical product purchases. As such, people consume services more, rather than buying products, which in turn facilitates more shared use. They eat at restaurants more and spend more time socialising and connecting.

People increasingly live in apartment complexes with communal spaces and shared resources, like household building tools. Some apartments even have food hatches in which meals are sent from a common, staffed kitchen. However, due to increasing demand for housing, prices and rent rise for many properties. Moreover, rising energy prices make many struggle with their living expenses, especially single households. Therefore, more people choose to live in collectives which helps them live greener, connect with more people and cut expenses. Moreover, governments offer economic incentives for living in collectives, like tax benefits.

Many people still travel for holidays but mostly travel by train. This makes tourism slightly more regionalised. Some also go for "stay-cations" as this is seen as trendy and a sign of being environmentally conscious. Flying has become more environmentally friendly, with less pollution, but also very expensive and heavily taxed. As such, the average person flies very rarely.

Politics

Sustainable change has to a large extent been created by regulations, but there has also been a cultural change. Due to the increasingly evident effects of climate

change, more and more people have started to prioritise sustainability and want to adapt to a sustainable future. Companies have had to struggle to adapt to much harsher regulations; some have gone into bankruptcy. Economic means of control have been used to strengthen "good" companies and have expedited a green transition.

Initiatives towards increased social equity have also continued. The wish for equity between countries is something many share, as well as for individuals. Further, many people have increasingly demanded a better work-life balance, especially in countries with hard and demanding work cultures and large disparities in income. This has affected regulations and the demands people have on their employers. In general, people feel that we must organise our societies and lives with long-term sustainability in mind, both in terms of ecological systems and individual health.

Community Planning

Town centres are built to be accessible to everyone. Cultural and communal spaces occupy the streets, like markets and parks. Traffic is organised to prioritise pedestrians, cyclists and public transport. Cars and trucks have limited access to town centres, both in terms of physical roads dedicated to them, as well as what hours of the day they are allowed to drive there. For example, heavy vehicles are not permitted during rush hours. The focus is primarily on favouring green methods of transportation, especially for personal transport.

Big investments are made in providing charging stations for EVs. They are primarily used for professional vehicles, since most people are expected to travel by other means. However, travel by electric motorcycles is made easy, with battery swap stations installed in cities. Passenger cars are usually only rented from carpools and unless you live in the countryside, you only rent cars for special occasions (moving etc). If any ad-hoc errands need to be done, people generally travel by bus or bike. They may also order a q-commerce delivery (which is delivered with electric motorcycles). However, this is expensive and therefore many only use it occasionally.

Industry

Circularity is central to every company's structure. Companies are careful not to waste materials and resources are often shared. Regulatory demands state that all physical products produced should be recyclable if possible (except things like hygiene/medical products), which forces companies to adapt to a more circular business strategy. Moreover, due to regulations and innovations, eco-friendly and new materials have replaced many unsustainable material uses (like single-serve plastic). These developments cause prices for new products to rise considerably and people cannot buy new products quite as often as before. While some products are still mass-produced, the production and sale of "wear-and-tear" products has decreased dramatically. Instead, handmade and high-quality objects that have a long lifespan increase in demand.

It is common for companies to sell a lot of second-hand and refurbished products in conjunction with production of new ones. When purchasing used products, they serve and quality check them so that the customer can be sure of what they are buying. Companies increasingly offer products and services related to repair and recycling/upcycling of their products. Due to the shift in consumption patterns, many companies focus on providing experiences, rather than selling objects. The leisure industry grows, offering more events and activities.

Power Supply and Fuel

Large investments have been made in green power. Solar-, wind- or hydropower are particularly favoured. Countries able to produce this often export power to neighbouring countries, whenever possible. Several countries also use nuclear power as a means to rapidly phase out fossil fuels. The risks of maintaining high levels of emissions are thought to be too great.

While the energy demand is still increasing, it does not increase as rapidly as previously predicted. This is due to the stricter regulations of consumption. Companies can be sanctioned if they consume much more than their rations and smart thermostats are used in every home to monitor temperature and power usage. Taxes are adapted to housing size and number of people living there, considering an expected consumption per individual. This means that individuals who exceed the expected power consumption or maintain either high or low indoor temperatures without claiming exemptions are subject to increased taxes and penalty fees. Exemption may be granted for specific health conditions or occupations that involve working from home.

Transport

Decreased overall production and localised industries will lead to an decrease in transports. Great efforts are made to reduce empty-mile driving; each trip should be productive and resource-efficient. This means a large overhaul in the logistics flow, prioritising more environmentally friendly options (see figure 10). Reverse logistics is an important part of this and products are often sent back to companies for repair. Further, there is an increase in recycling transport since most household waste is put in recycling bins.

Large investments are made in renovating and upgrading harbours and train networks to allow for more diverse, eco-friendly transportation modalities. Big intercity transports are mainly done with cargo trains because of their enormous load capacity. On uncrowded train lines, cargo- and passenger cabs are often mixed. Because travelling on water is often a fuel-efficient option, boat freight is increasingly used for shorter distances, travelling on rivers and lakes as well as the sea.

Transportation within cities is done with electrical trucks to smaller local logistics hubs in bulk, often tied to a specific apartment complex. Because of this, most orders are not sent directly to homes and must instead be picked up at postal service agents.

As a fair portion of second-hand purchases are made online, often by private sales, many packages have odd shapes and sizes, making them somewhat hard to transport. However, returns of goods from online shopping have decreased due to stricter policies and higher return prices (as well as decreased consumption). Delivery times have also increased significantly to avoid low fill rates, and consequently consumer expectations have shifted away from fast deliveries. Sometimes delivery companies put non-urgent deliveries on hold until more cargo can be consolidated on the same route.

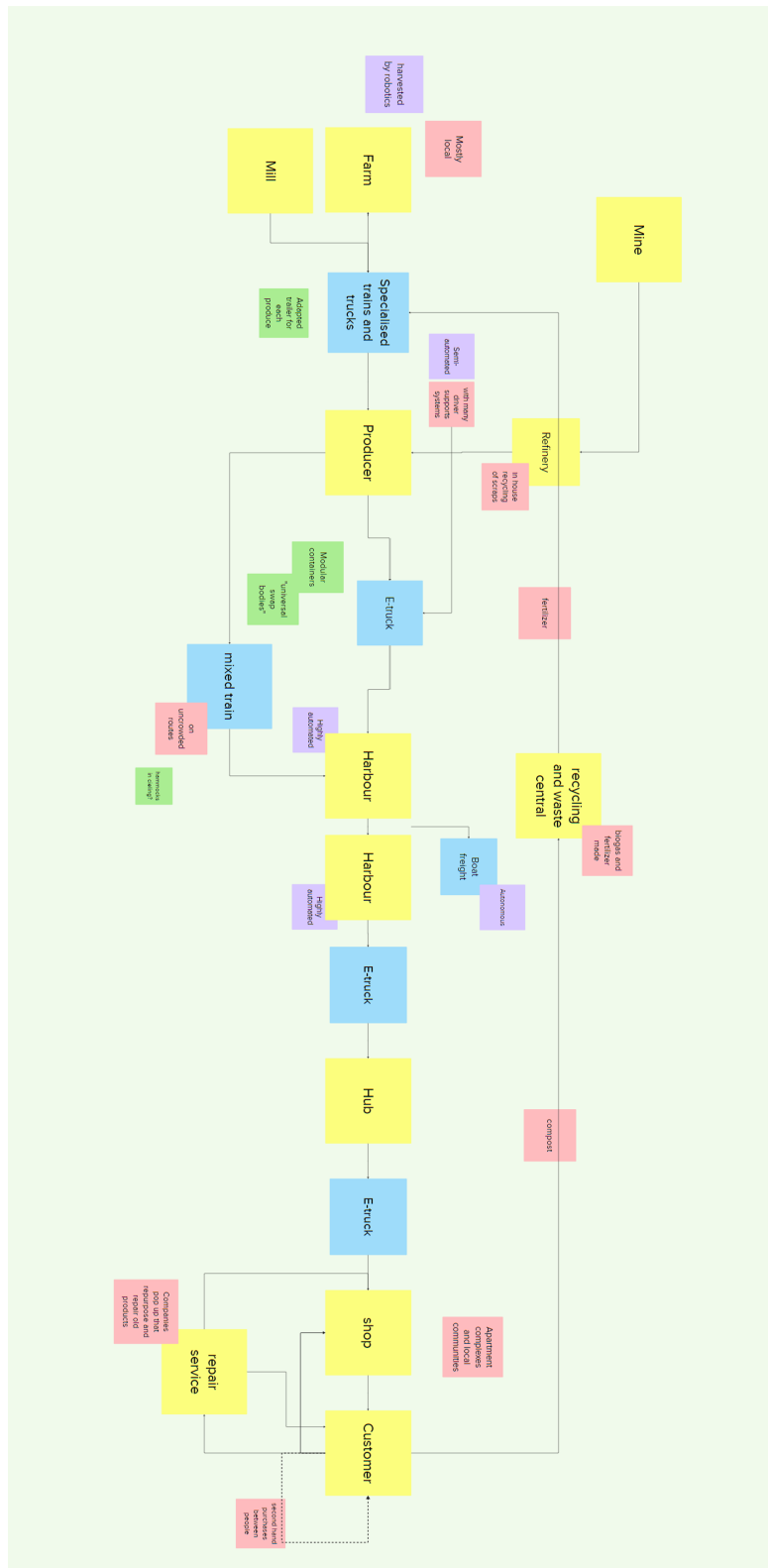


Figure 10: A flowchart showcasing an example of a logistics system in Green Future.

4.3.2 High-tech

This scenario describes a future in which technological development has continued to radically change society, at an ever-increasing pace. The world has become more and more interconnected, both physically and digitally. Despite tensions between certain nations and the vulnerability of these highly interconnected systems, the world has become completely reliant on them. Cities grow globally and form local connections as part of the globally expanding web.

Key trends: Rapid Technological Development, Digitalisation, Urbanisation, Globalisation, Technological Breakthroughs

Keywords: Consumerism, Individualism, Efficiency, Digitalisation, Interconnectedness

Lifestyle and Living

People are used to very high-paced lives with quick services, deliveries and constant access to information and entertainment. Many spend a lot of their free time online and most daily tasks can be done with the help of their phones and AI assistants. Almost all shopping is done online and deliveries are usually very quick, using drones and robots. Companies often only have stores online, while having physical showroom stores in town. Customers may look and examine their products in reality and then order home the product.

While most people live in cities, digitalisation has allowed a large portion of professions to work remotely. Therefore, more people with office jobs sometimes choose to live in rural areas or in smaller towns for the idyllic surroundings. However, because so many stores and services are online, and deliveries are so quick, they do not lose much convenience.

Personal health and physical status are tracked for individual use. This data, however, is also used by the state and commercial companies for big data analysis. Personal data can even be used as a form of payment in several cases. Services and products are highly tailored to individual wants and needs often using algorithms and personal data. 3D printing customised products have become very common, which has led to an increase in material freight in and near cities. These products are designed using advanced scanning tools and digital tools allow people to create their own personalised products. New technologies and materials allow people to consume at a fast pace with a reduced environmental impact. Meanwhile, there is also an increase of servitization and shared use for products that are used rarely, helping to further reduce the impact.

Politics

Sustainable change has been driven to a large degree by innovation and industrial initiatives. Historically, law- and policymakers have struggled to keep pace with

rapid technological developments, often only able to establish broad directives to mitigate undesirable developments. However, in recent years, governments have developed more efficient methods to swiftly evaluate, regulate, and occasionally restrict new technologies. With the help of AI tools, they have become more adept at directing societal development.

Many countries lack the resources and expertise necessary to compete in terms of technological innovation. As a result, their politicians place significant emphasis on strengthening relationships with international trade partners. Moreover, individuals who struggle to keep up with advancing technologies or acquire an advanced education are largely unable to find employment. Instead, they become dependent on the state or relatives (depending on which country they live in).

Smartification, meaning connecting analogue products with sensors (DHL, n.d.), has enabled politicians to greatly rely on big data and predictive technologies to make decisions. However, these highly connected systems are fragile to cyber-attacks. Therefore, cybersecurity is of utmost importance in all societies. However, the politicians' use of the information also poses a societal risk. The extensive monitoring and access to information makes it easier to manipulate the population. Moreover, false images and evidence can easily be fabricated. In countries with authoritarian governments, being in political opposition is extremely difficult.

Community Planning

City planning is guided by big data analysis. Sensors are installed throughout urban areas, integrating all infrastructure into the Internet of Things. Cities have been adapted to accommodate autonomous vehicles travelling to and from large hubs, from which the cargo is distributed. While autonomous vehicles have yet to be successfully integrated into regular city traffic, smaller autonomous delivery robots travel on bicycle lanes and sidewalks. Drone centres are used to deliver goods to people in and around small cities. In larger cities, individual deliveries are usually done with larger robots, travelling on bike lanes. Some roads are dedicated to very high-speed transport, but these are often placed underground. Further, certain cities have started building different types of infrastructure at different levels, separating transport roads and recreational, public areas.

The power grid can adapt its supply based on forecasting and buildings can save power by IoT optimisation systems. Similarly, waste and pollution can be minimised because of smart solutions. For example, since the traffic situation is always known and the information easily accessible, the quickest, most energy-efficient route can always be planned.

People's personal data is used by authorities to plan traffic, infrastructure, logistics, health care- and disaster resources. For example, the spread of diseases can be tracked and predicted by registering each case. However, while this use of data allows for efficient planning and use of resources, personal integrity is compromised.

Many people appreciate the benefits but dislike that so little personal information is private.

After the COVID-19 pandemic, companies have adapted their supply to handle more disturbances. While strong international trade is still maintained, temporary delivery stops, changed logistics routes and sanitation stations in border controls are sometimes necessary to limit the spread of diseases during outbreaks.

Due to everything being connected, a lot of focus and resources are put into cybersecurity. Occasionally, in the case of a disturbance, people are unable to work, shop or do any errands. However, necessary societal resources, like ambulances and hospitals, have some form of backup solutions.

Industry

Thanks to rapid technological development within most areas, production and consumption continue to rise. Some companies, producing highly advanced products become increasingly specialised. Because most technology is part of a highly connected system, companies are increasingly forced to share information and develop products in cooperation.

Further, different countries become specialised in different industries. This drives companies to adopt a global operational strategy, locating their facilities in countries specialised in their industry. In many industries, large companies often buy smaller ones to create complete control over the entire chain of production and transportation.

As AI and robotics continue to develop, more and more industries become automated and connected. Thanks to smartification and the Internet of Things, every part of the production flow can be accessed, monitored and controlled remotely. People who can work from home often do and are monitored to a certain extent to keep up productivity. Maintenance is done before any issues arise, which minimises the occurrence of breakdowns within the entire production and logistics journey.

Power Supply and Fuel

Due to the continued growth in production, the demand for energy will continue to grow rapidly. More and more products also require energy to operate. A lot of money is therefore being put into expanding existing green energy sectors (such as hydro, solar and nuclear) while also being put into developing technologies. This includes more efficient existing solutions and entirely new ones, such as fusion energy. In the case of fusion technology, people hope that this will provide the solution for the environmental crisis.

Transport

Maximum efficiency and speed are central to companies and consumers. The logistic flow is extensively streamlined and optimised, with most operations performed by automatic systems (see figure 11). Cargo is shipped between large (often multi-company) hubs where it is quickly sorted and separated for the next leg. Moreover, packaging has become heavily standardised to easily fit into automated systems. Even though many products are custom made, the orders are placed in standard packages. However, this often means that a lot of cushioning material is used.

On the highway, cargo is driven by large autonomous trucks. Roads between large hubs and have been equipped either with charging roads, eliminating the need to stop, or charging stations. When a tractor stops to charge on a long route, another fully charged tractor can pick up the trailer and continue the journey. Telematics and AI permit the fleet to plan these handovers efficiently.

In cities, trucks are still driven by humans as self-driving vehicles have proven difficult to integrate in cities and crowded environments. However, the driver is helped by various supporting functions in the truck. Every vehicle's path and load is optimised through AI and big data in order to create faster, cheaper and resource-efficient deliveries. This is achieved through swarm intelligence, telematics and shared information throughout fleets. Some of this information is also shared across companies, for example traffic flow, as this is seen as mutually beneficial. However, many are still guarded, not wishing to share more than they have to since data is valuable.

Home deliveries to private consumers are made directly to the front door. Normally, autonomous solutions are used, such as drones, robots and smaller self-driving trucks. However, if the delivery route is too complex for robots to travel, a courier will make the delivery.

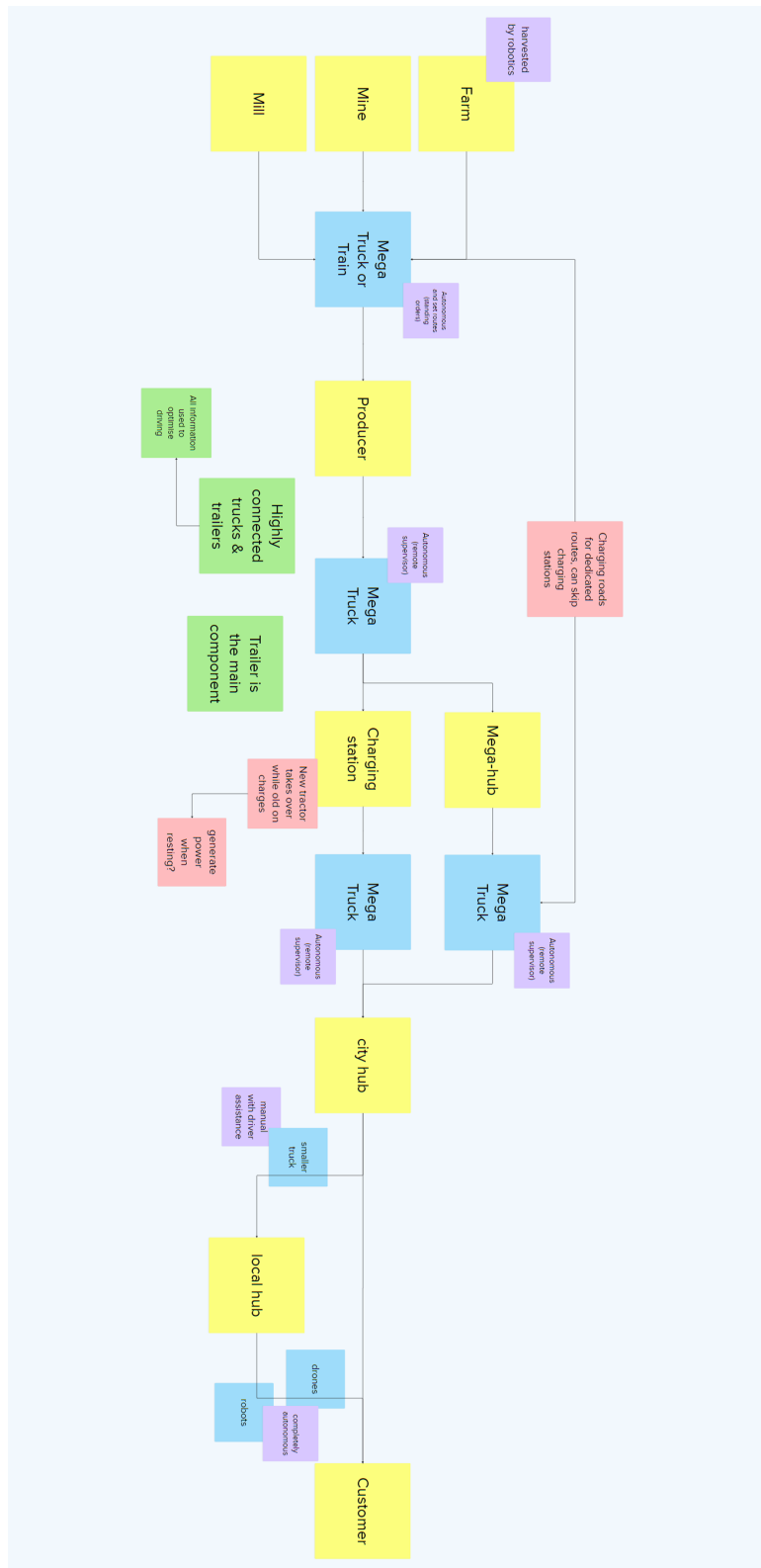


Figure 11: A flowchart showcasing an example of a logistics system in High-tech.

4.3.3 Lonely Planet

Lonely Planet describes a world with rising conflict between nations. The consequences of global warming, like extreme weather, food insecurity and increased pandemics, put a strain on all societies. This further exacerbates conflicts, leading to increased physical and digital warfare. External threats are a constant presence. Political conflicts drive nations to decrease international trade and countries increasingly rely on allied countries and neighbours, which leads to a shrinking and divided world. Many connections are cut and trade restrictions are set. Everyone must adapt to survive on the limited available resources.

Key trends: Pandemics, Regionalisation, Global Warming

Keywords: Crisis, Cybersecurity, Frugality, Resilience

Community Planning

Efforts are made to create infrastructure and resources adapted to extreme weather and other situations of crisis. For example, flood wells are built underground. Food, power and emergency supply reserves are built. Alternative, analogue ways of operating are created for necessary societal functions, such as the health care system, police, fire brigade, food production and grocery stores. While advanced technology exists and is used, governments do not want to risk breakdowns in the case of power cuts or cyber-attacks. However, AI and drones are used in agriculture to make it more efficient. Extreme weathers ruin too many crops to refuse any tools for increased production.

Efforts are made to use green building materials and bike lanes and public transport are improved. However, full vehicle mobility in the town centres is maintained and prioritised, should for example ambulances or crisis workers need to move through. More people also work from home when they're sick (even for colds) to a larger extent since the COVID-19 pandemic. New social norms dictate that you stay home if you're sick. Therefore, traffic with personal cars has slightly decreased. Loss of biodiversity has led to a significantly elevated risk of a new pandemic and many governments are apprehensive of outbreaks of new diseases. Many governments have begun to make regular public service announcements, encouraging people to socially distance themselves if they are ill.

Lifestyle and Living

Most people have had to adapt to a decreased offer of produce in stores. What is available also changes for different seasons. People's diets have become more dependent on the seasonal variation within their own country. When some countries experience poor harvests due to extreme weather, neighbouring countries can often help, but some years there are shortages. However, the rich can still access exotic produce and goods. Class differences become larger and there is increased social tension and resentment towards the higher classes living lavish lives with a high

carbon footprint.

Due to more regionalised economies, the homogenisation of cultures (following globalism) slows down and local cultures become more distinct. Patriotism and a sense of collective responsibility increase.

There is an increase in mending, repairing and second-hand purchases, both due to environmental reasons but also because people have become more intolerant of waste. Due to increased competition for natural resources, most products have become more expensive and purchases are investments to a larger degree. Smart products are often considered unnecessary and extravagant; simpler solutions (when possible) are preferred. It is still normal to use smartphones and spend time online, but there is a low demand for connected “smart homes”. Meanwhile, people also spend more time doing analogue activities and doing sports, trying to keep healthy. There is a wariness of what negative effects excessive screen time may have on both mental and physical health. Moreover, many worry about the radicalising effects internet use can have on people. The prevalence of alternative facts and propaganda is considered a serious threat.

Many want to live greener and some use more public transport. This development is also driven by rising costs of living and technology. Public transport continues to use the same kind of vehicles as today, without any large innovations. The electric grid with charging stations is gradually built up and expanded but at a fairly low pace due to the costs. Standards concerning these stations become localised to regions. Many keep using the cars they have, not wanting to buy an EV yet.

Industry

There are occasional shortages of rare earth metals. China takes advantage of their unique position of mining most of the world’s rare earth metal supplies. Halting exports is used as a political bargaining chip, causing occasional scarcity and an increase in prices. Therefore, production and technological development suffer in periods. Because of this, advanced technology becomes more expensive. This, in combination with cybersecurity issues, causes a decreased willingness to rely on digital and connected solutions and create a move towards using simple solutions when possible. Therefore, both advanced and simple technology are used in product development. Moreover, investments are put into research and manufacturing of alternative materials and substances.

Companies’ production and sales become more localised. Some countries are still specialised in producing certain goods, but the economies generally become more diverse as countries can’t rely on exports and imports as much. Some manual jobs return to countries that have previously moved their industries to Asia or to poorer countries. However, there is still enough automation to inhibit the increase in new jobs.

Local tourism has become more common and is encouraged. However, there is still some tourism and travel across continents. Countries with very tourist-dependent economies, like Thailand, invest in maintaining a flow of tourists.

Through political efforts, a lot of companies focus on sustainable products. Higher efforts are put into repairing, repurposing and recycling, all of which create new business opportunities. A lot of companies combine this with services as the only option to survive in a decreased consumption society.

Politics

Political efforts are largely aimed towards preserving and developing local interests. Both physical and digital barriers are put up between regions. Foreign investments and collaborations are restricted, leading to a more fragile world order since many countries are less dependent on each other. Additionally, more money is spent on defence and highly advanced technological weaponry.

Local politics focus on a circular economy, partly for a more sustainable society (which is seen as important), but more importantly to keep the industry afloat and self-sustaining in a resource-scarce world. Highly technological products (such as AI) are rarely sold or shared internationally to keep an edge over rivaling nations. Because of this, differences between countries in terms of development become much greater.

Due to rising collectivism, patriotism and restricted influence from other parts of the world, extreme political views spread. Some areas see political turmoil and anti-democratic influences increase. This, in turn, leads to a more divided and unequal world.

Rare earth metal export is a bargaining chip in weaponised independence with China. The supply sometimes comes to a halt during political disputes with some countries. As a response to this, other countries try to decrease their dependence on China by establishing their own production and supply from other countries. The aim is to create a diverse supply chain and a more equal power balance.

Power Supply and Fuel

While progress has been made to reduce emissions, not enough has been done to meet climate goals. Most countries try to make a green transition, but many rely on the resources they can source from their own country. Those with large reserves of coal, gas and oil use these for power and fuel. However, some have advantageous natural resources allowing them to rely on solar-, wind- and hydropower to a large extent. Close neighbours can also help each other by providing green power.

Transport

While logistic chains still exist between countries globally, many transports are concentrated to limited regions. Transportation from and into harbours decreases as international trade between continents decreases and resources must be found locally. Many companies put effort into establishing networks of reverse logistics (see figure 12). They seek to salvage and repair products in order to save on resources and increase income on the local level. Some companies have their own salvaging solutions for their own products, while other companies focus on general recycling. This is further encouraged through politics and communal efforts.

There is an increase in long-haul land transportation via trucks and trains within regional boundaries. While train transport is important due to its loading capacity, a breakdown of a track can cause a complete stop in train traffic. Therefore, trucks are preferred in many cases since they are more flexible and therefore resilient.

While technology is used to make operations efficient, no one dares to fully rely on IoT solutions systems. Technological systems always need to either be air-gapped or have backup systems that can operate offline. In many cases, there are also manual backup systems. Therefore, trucking is still reliant on there always being a driver present in the cabin. In the case of an internet outage or a cyber attack, they have to be able to drive the truck manually.

Since technology and autonomous vehicles have been unable to replace the driver, the conditions in the profession have had to change to mitigate the driver shortage. To make the profession more attractive, a "tag system" of transportation becomes common. In this system, drivers travel in one direction for half a work day, swap trailers and then return home. Trailers travel long distances through these types of networks. This permits truck drivers to have regular working hours and eliminates long periods of absence from home.

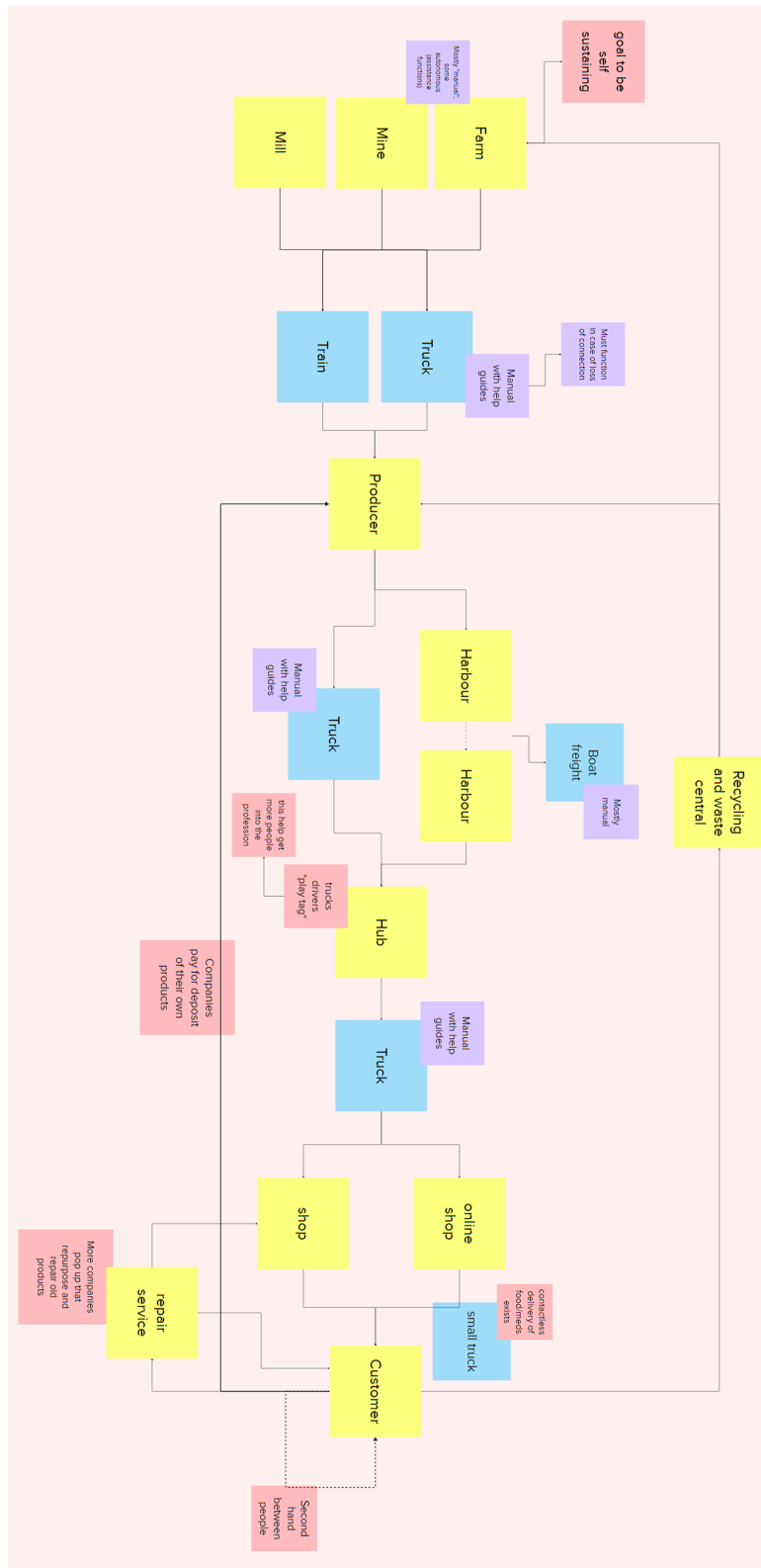


Figure 12: A flowchart showcasing an example of a logistics system in Lonely Planet.

4.4 Design

In this section, the two concepts, Klotski and Mancala, are presented. They are described in terms of their intended functions as well as what needs they address. The two concepts are also compared to their relevance for each scenario. Finally, an evaluation of the concepts are presented, which is based on the input from the focus group.

4.4.1 Concept 1: Klotski

The first concept is mainly rooted in the high-tech scenario. It is based on the use of advanced IoT solutions and a wish to speed up and streamline processes. Further, since shopping is almost exclusively done online, there is a large flow of individual parcels with separate delivery addresses. (Therefore, the concept is mainly aimed at companies such as DHL or PostNord, that deliver packages to individual consumers.) These factors led to the idea of moving sorting operations from warehouses into the trailer. If this can be done automatically in the trailer, much time could be saved. However, this product is harder to fit into the other scenarios. Its highly connected technology does not align with Lonely Planet’s focus on resilience against cyber-attacks. Neither does the added weight of the mechanisms and its low fill rates align with Green Futures emphasis on sustainability. It is primarily adapted to a world in which speed and streamlined processes are even more central than today.

In order to facilitate efficient sorting, it was decided to make the cargo into moving units. The concept was inspired by games like Klotski and 15 puzzles (see figure 13) and is therefore named after them. The principle in these games is that if one slot is empty, the puzzle pieces can be moved around into any new configuration. By moving the cargo the need for a sorting mechanism capable of reaching, lifting, and moving cargo throughout the entire trailer is eliminated. Such a mechanism would likely be very complex and heavy. Moreover, moving the cargo reduces the issue of the packages obstructing its reach. However, routes need to be long enough to give the automatic system time to sort the packages. Therefore, such a concept could fit into the fast-paced high-tech scenario’s delivery systems with autonomous long-haul trucks, full of individual packages.

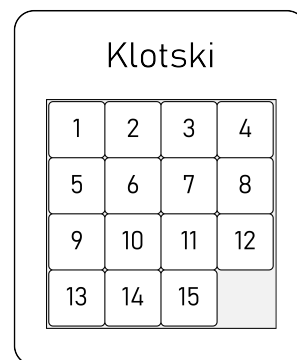


Figure 13: An illustration of a Klotski game.

Description

Since the concept is adapted to varied, non-homogeneous cargo, the trailer has been divided into two zones: one for large, heavy cargo and one for smaller cargo (see figure 14). The heavy cargo is placed on the floor, where it is moved by moving floor mechanisms, such as pneumatic balls or wheels. These mechanisms are capable of moving both sideways and back and forth. They can also operate in separate sections, making it possible to move different packages in different directions (see figure 15).

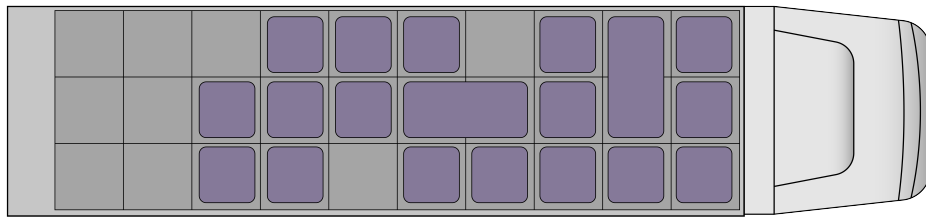


Figure 14: An illustration of the Klotski concept, seen from above. The area presented is the heavy cargo area, in the bottom of the trailer. The grey squares represent moving mechanisms, and the purple squares represent cargo.

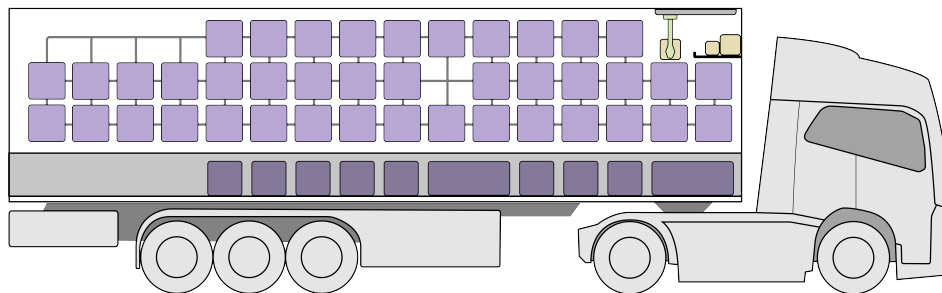


Figure 15: An illustration of the Klotski concept, seen from the side. The white area represents the light and small cargo area, while the grey area represents the heavy cargo area. The light purple squares represent shelves and the dark purple squares represent heavy cargo. The green represents the sorting robot and the beige represents light cargo.

Light cargo is placed on moving shelf units. These shelves reach across the trailer (see figure 16) and are attached to rails on the side walls. In these rails, they can be moved around in a coordinate system.

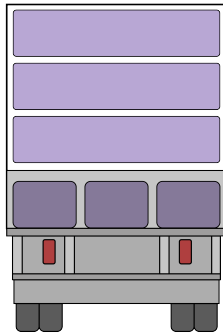


Figure 16: An illustration of the Klotski concept, seen from behind. The light purple squares represent shelves and the dark purple squares represent heavy cargo.

The shelves can be constructed in several different ways. To secure the cargo, they have raised sides. These may either be solid or have cutouts to offer easier access to the cargo. If the package dimensions are standardised, as in the high-tech scenario, a stiff, solid shelf may be preferable to have minute control over the space inside the trailer. However, if the packages vary more in shape and size, a partially soft version, made of slightly stretchy fabric or net, may be preferable as it can better adapt to odd shapes. While this solution would demand a bigger gap between the shelves, their shape can still be somewhat controlled by solid elements. For example, the bottom and short-end sides of the shelves may be hard.

The packages on the shelves are sorted by a robot in the trailer (see figure 15). This is attached to the roof as this may provide the best angle of access. The robot needs to be able to identify the packages in some way, as well as to grab and lift them. Therefore, it will likely need to be able to see and scan the labels on the packages. It has two arms that can move across a traverse system in the roof. They can either act separately or cooperate. This way, it can handle various shapes and sizes. For example, if a package is long or bulky, it can be lifted by both arms. If the packages are smaller, they can work in parallel, increasing efficiency. Moreover, to make space for a new package on a moving shelf, it may be necessary to have a dedicated shelf space next to the robot for temporary storage (see figure 15).

Since all units in the trailer can move automatically, on- and off-loading can be streamlined. Cargo can be fed into the trailer automatically, as well as moved towards the opening. This would eliminate the need for people to move in and out of the trailer.

When loading cargo into the trailer only a rough sorting would be necessary, separating small and large packages. The large packages are placed on the floor and scanned into a TMS system. To enter cargo into the trailer's system, the scanner is held to a device on the wall by the trailer opening. The smaller packages can be loaded onto a shelf and scanned into the system in the same way. Scanning the packages would help the trailer system know what cargo it is carrying and roughly where it is located. This would help speed up the sorting in the trailer, eliminating the need for the system to locate and identify all packages when driving. However, if the route is sufficiently long, this step may be skipped, leaving all work to the trailer and reducing warehouse operations.

4.4.2 Concept 2: Mancala

The idea for this concept was partly inspired by the Klotski concept. It also relies on cargo being moved automatically inside the trailer. However, the function is different. Instead of sorting cargo, it is only intended to be able to adjust the weight distribution inside the trailer. While it relies on sensors and IoT solutions, it is not as advanced as Klotski. Moreover, the value it provides is not increased speed and efficiency. Rather, this would help to balance the axle forces and move the centre of gravity when needed. This could potentially help increase maximum load capacity.

Since one of the main causes of sway is incorrect load placement, automatically adjusting the weight distribution throughout the route could improve stability when driving. This system could be helpful both for the initial on-loading, since it eliminates the work of calculating the correct placement, and for routes with multiple stops with partial off-loading. Further, should the truck need more traction on certain wheels when driving, adjusting the weight distribution would help. For example, when driving up a hill, perhaps in slurry, this function could be useful.

Due to climate change, the weather is likely to continue becoming more unstable with rapid shifts. Measures to improve vehicle stability and wheel traction could contribute to making trucks more adaptable to such swiftly changing road conditions. These benefits are more adjusted towards the Green Future scenario, but the Lonely Planet scenario in particular. Both scenarios are centred around efficient resource use, but Lonely Planet emphasises the consequences of climate change more.

Its name is taken from the board game Mancala (stems from the arabic word "to move" [Burgess & Gamble, n.d.]), where marbles are moved strategically across a board of grooves (see figure 17). Similarly, in this concept, cargo is strategically moved across a horizontal plane.

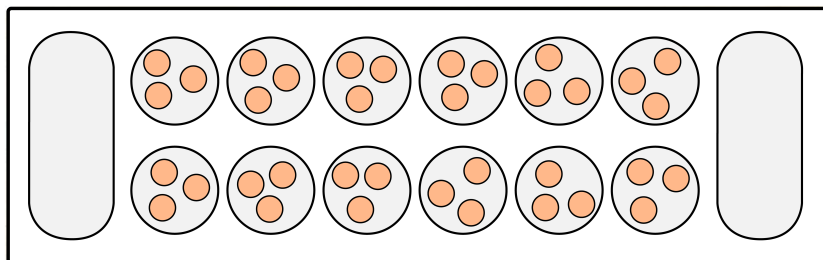


Figure 17: An illustration of a Mancala game, seen from above.

Description

The cargo is loaded onto the trailer floor at the trailer opening. It is moved into the trailer by moving floor mechanisms, such as axles of wheels or strips of conveyor belts (see figure 18 & 19). These mechanisms are segmented into sections that operate independently, allowing different cargo sections to be simultaneously maneuvered to optimal positions.

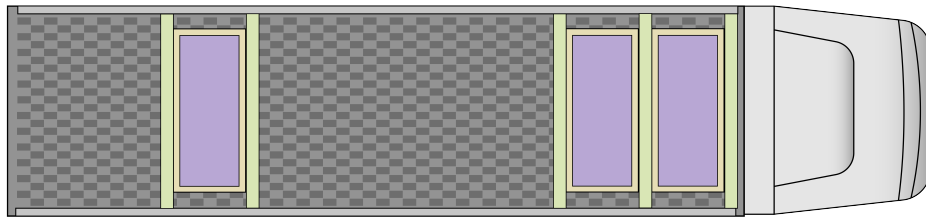


Figure 18: An illustration of the Mancala concept, seen from above. The checkered area represents the floor of wheels. The green represents movable sections and the purple represents cargo.

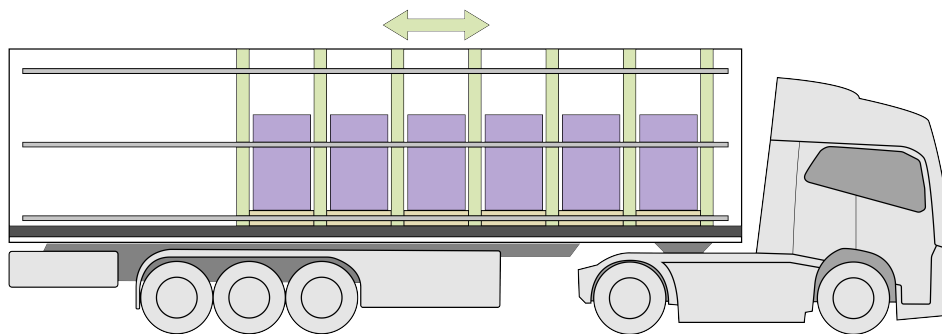


Figure 19: An illustration of the Mancala concept, seen from the side. The green represents movable sections and the purple represents cargo.

The units of cargo are divided and secured, both from the front and back. This is done by attaching securing components such as nets, straps or bars to rails on the wall (see figure 20). These components can be moved back and forth along these rails. There are three height levels on these rails. To further facilitate the on-loading process, securing components can be attached at mid-height, either above or below the mid-rail. They then move up or down to their desired position. The securements move together with the units of cargo.

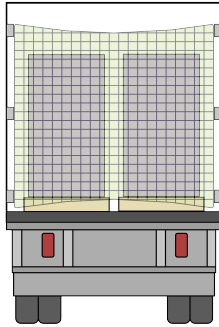


Figure 20: An illustration of the Mancala concept, seen from behind. The green represents a movable section, in this case made of net. The purple squares represent cargo and the beige square represent pallets.

An alternative way to move cargo could be to let the securing components push the cargo. This could be done by having a passive, moving floor, meaning that the cargo can roll freely over it. The floor could consist of rolling cylinders, like a form of passive conveyor belt. However, in this case, it is important that it can be locked. During transport, the cargo needs to be properly secured. Therefore, it may be necessary to have friction on the floor.

4.5 Evaluation of Concepts

Both of the concepts were received with some interest during the focus group, particularly the Klotski concept. However, according to the participants, neither of the concepts were completely novel; there are other companies investigating similar ideas. This was especially true for Klotski, where although there are few products with comparable functions currently on the market, numerous patents exist for similar concepts. However, this does not necessarily mean that the concept should not be further developed. The patent engineer stated that this indicates that there may be value in developing such concepts. Meanwhile, the existence of competing concepts necessitates specific mechanical descriptions in order to guard and differentiate a product.

Concept 1: Klotski

While the Klotski concept was not entirely unique, it was perceived to still have some novelty value. It also inspired some further concept ideation among the group. For example, the fact that it can sort items in any configuration, inspired ideas of special zones within the trailer, such as safety or cooling zones. Another idea was to allow for the shelves to be used as a form of small-scale containers.

When it came to discussing the concept's potential use in each scenario, the focus group confirmed that it was closely tied to the fast-paced world in the High-tech scenario. Moreover, they found that its potential use was largely limited to parcel and mail deliveries. The low fill rates would be a very large disadvantage in most other

cases. However, as delivery companies highly prioritise speed, the group perceived that the concept could have potential value for them. When asked what the next step of development could be, they stressed the need to specify the exact context to develop the product for, for example by collaborating with a delivery company. One of the participants stated, “If there was one product that would be perfect for all areas of application, it would be invented already”.

Because the concept is focused on speed rather than resource efficiency, the group found it hard to fit into the Green Future or Lonely Planet scenario. However, they came up with the idea of combining the sorting system with cooling zones for pharmaceutical deliveries. As deliveries could be made contactless, using the sorting system and even the idea of mini containers, the concept could be useful during a new pandemic. This application suited the world described in Lonely Planet where pandemics pose an increasing threat.

Concept 2: Mancala

Mancala was perceived as simpler and less innovative. However, the group could see several potential benefits of such a product, like decreased tyre wear and improved fuel efficiency and drivability. Mancala was primarily found to be suited to the Green Future and Lonely Planet scenario, because it could potentially contribute to efficient resource use.

According to one of our supervisors, the development of this type of product is closer to Volvo Groups’s current core business and the type of products they have in their product range today. Therefore, it could be further developed and tested quite easily by Volvo.

5

Evaluation of Methodology

In this section, an evaluation of the method used to create the scenarios is presented. The evaluation includes both our personal reflections on utilising the method and external input.

5.1 Evaluation of Scenario Building Method

When reflecting within the group on our subjective experience of the methodology, we found that the methods had supported our work process well. During the trend research, reading a large amount of articles from many different sources helped to create a personal, intuitive understanding of various trends. Moreover, organising all the collected material in a digital workspace helped us map and connect related information as well as create an easily accessible overview. Eventually, we experienced that we reached a degree of saturation in our trend research; new sources largely presented familiar trends and observations. Therefore, our experience is that the method of trend research helped us meet the criteria of degree of integration in an easy and organised manner.

“If this is true, what else is true?” was an easy method for creatively combining trends and exploring their joint impact. The Swedish Energy Agency’s scenario format with set categories further helped us to consistently explore the implications of the trends further. All trends needed to be applied to the same set of societal aspects. We experienced that this format was useful to achieve consistency, making us consider the internal logic within each scenario. Moreover, it also helped us create scenarios of equal detail, exploring each hypothetical world in a consistent way.

When creating the scenarios, having gathered a wide range of information was important. It helped us to discuss and elaborate, weighing various perspectives against each other. However, while writing the scenarios, continually discussing how trends might interact, new questions were constantly sparked. (For example, questions about sustainability led us to read about recycling systems and how natural gas is made.) Therefore, we eventually had to stop ourselves from researching too many new subjects. While we felt that we had reached a high degree of saturation in our trend research, there was no natural stop to researching related topics. Overall, constructing the scenarios took a long time. However, as described by the criteria time and effort involved, the quality of scenarios are often proportional to the time spent constructing them. Therefore, while the long time used in this project is a

disadvantage, it may be defensible if the scenarios can be shown to be of high quality.

The scenarios were subject to continual, formative evaluation throughout Phase 1. The interviews provided us with additional insights and knowledge, helping us understand how different trends might develop. This is something which helped us nuance and ground the scenarios. However, because the interviewees provided different perspectives, it is reasonable that their opinions would differ. Some experts found different scenarios to be most likely. The two most favoured scenarios were Green Future and High-Tech, which were selected as most probable to an equal extent. This indicates that they meet the plausibility criteria to a similar degree. In contrast, while the scenario Lonely Planet sparked the most interest, some found the catalyst trend of regionalisation to be very unlikely. Because regionalisation, a catalyst, is central to Lonely Planet, this result is not surprising. However, during the interviews, the scenarios were positively received and met with interest. They were generally perceived to capture possible yet different trajectories. Therefore, while Lonely Planet is not as plausible, the scenarios do overall meet the criteria of plausibility and distinctness. However, because Lonely Planet described a more novel trajectory, it sparked the most interest and discussion among the interviewees. This may indicate that the decreased level of plausibility helped to trigger new thoughts. As mentioned previously in the report, scenario planning often places heavy emphasis on catalysts. Doing this to a larger extent may have generated more thought-provoking scenarios.

Our supervisors and the focus group at Volvo found that each scenario described a set of different, plausible trajectories, further indicating that they meet the criteria plausibility and distinctness. We also received comments that the scenario summaries were well developed and clearly described, which indicates that the scenarios meet the criteria of consistency and comprehensibility. Additionally, the team at Volvo perceived that although the scenarios depicted different futures, they could coexist to some extent. This suggests a lower degree of distinctness but provides the opportunity to combine them during ideation. They appreciated this aspect as it may help developing products adapted to several possible developments. The scenarios non-exclusivity is an effect of constructing our scenarios primarily around varying emphases on megatrends. Had we centred the scenarios around catalysts, they would likely have been mutually exclusive to a larger extent. The results may have been more thought-provoking, but may have offered few overlapping opportunity areas. Therefore, relying more on megatrends when constructing scenarios could possibly contribute to making relatively safe investments. For a company with long product development cycles this may be an advantage.

Some of the designers at Volvo Group expressed that they wished to read our scenarios further. Similarly, one of supervisors stated that they will return to our scenarios and workboard for new thoughts and inspiration as the gathered material could be used to generate more concept ideas. One designer also suggested that the scenarios could be used to evaluate concepts by checking if an idea would fit into the projected futures. Another participant, the patent engineer, suggested that there

may be organisational benefits to working with future scenarios in a similar way. By describing future contexts and what customer needs may exist, this could potentially help to structure development work within a company. He suggested that this could facilitate patent applications for new innovations since new products will always be clearly tied to solving a specific need. Overall, their comments showed that they saw potential use for the scenarios in their innovation work and that they intend to revisit them. These responses relate to our research question: “Will the chosen method of scenario building provide a useful basis for design?”. Our contacts at Volvo Group have, in various ways, expressed that they believe that our scenarios can function as a useful basis for design work and innovation.

During the focus group discussions, we tried using a short summary of the scenarios as a tool for spontaneous, further ideation of the concepts. However, the comments of the group indicated that this was not effective for reshaping the existing concepts. Rather, the discussion mostly confirmed in which scenario the concepts would be appropriate. In contrast, during our own process, we found that this method sparked ideas and supported creativity. Within a few days, we developed a selection of opportunity areas and concept ideas. However, we primarily used the method as support during this initial stage. As we further developed the concepts, the scenarios continued to influence their functions, but the concepts began to follow their own internal logic.

In total, the feedback we received indicates that the scenarios meet the set quality criteria. Therefore, while the process was time intensive, the results are of sufficient quality to justify this. The feedback from Volvo Group shows that the scenarios can be of further use to their company. We also experienced that the method supported our work well. Our conclusion is therefore that the method of constructing the scenarios has been successful.

5.2 Evaluation of Ideation & Conceptualisation

During the opportunity exploration activity, it was decided that we should focus on one opportunity area. This decision was taken during a meeting in agreement with our supervisors. It was partially due to time constraints, but mainly because this appeared to offer the most potential value to Volvo’s customers. This estimation was based on our supervisors’ insights and knowledge of Volvo’s business. Moreover, by focusing our efforts on one concept, we hoped to include a larger portion of a design process in the project. However, doing this fast-paced conceptualisation meant that our focus narrowed down quite suddenly. Therefore, only a short time was spent exploring the solutions spaces of the scenarios.

According to the participants of the focus group, more value could be gained from showing a wider range of concepts during the discussion. One participant stated that technological details are not important for innovative work, but rather to provide a wide range of ideas. When presented with a wide range of concepts, experts and

decision-makers can choose the most promising alternatives to continue working on. He stated that this was especially true when working with products that might be relevant 15 years in the future; the technological details can always be determined at a later stage by the appropriate company department. In general, the focus group believed that presenting a larger selection of ideas with lower fidelity might have led to a more open and productive discussion and better illustrated the scenarios potential as a creative tool. Moreover, participants' expert knowledge in design and creative work might have been better utilised. Based on this feedback, we draw the conclusion that it would have been beneficial either to have developed more concepts in parallel or conducting the focus group in an earlier project stage, when more concepts were being considered. Further, spending more time exploring the design spaces of the scenarios, and especially their overlapping opportunity areas, would have explored the scenarios potential better; particularly the fact that they were non-exclusive.

The participants in the focus group felt that the work behind the extensive scenario building was not reflected in the designs. Instead, they expressed a wish that we had spent more time exploring how the scenario building could be more clearly incorporated. However, they acknowledged that this can be a difficult thing to do and often poses an issue in product development; to embody future predictions and visions in concrete products and solutions can often become a disjointed process. It is possible that concretising the scenarios further by listing needs and requirements in a structured manner could have helped this process. However, the prevalence of difficulties in translating scenarios into designs suggests that this step may not have been sufficient. Moreover, even when spending much time at this translation process, it is possible that many concepts would not be able to fully reflect the societies described in the scenarios. Instead, it is likely that some ideas will be tied to the differentiating or limited aspects of them. For example, the Klotski concept was closely tied to aspects that were distinctive to the high-tech scenario, such as efficiency, speed and highly connected solutions. Because of this reason, the Klotski concept may be considered ill-suited to showcase the extensive work put into building scenarios. This further strengthens the argument for presenting several concepts, covering a wider range of opportunities within the scenarios.

Our experience aligns with the focus groups feedback; translating the scenarios into concrete products was the most challenging hurdle. Many questions arose when beginning to investigate opportunity areas and much time was spent trying to interpret what concrete consequences each scenario had for the truck and trailer industry. However, our processes still lacked tools for translating the scenarios into concrete products. Meanwhile, we had not encountered any such methods during our method research. This, in addition with the focus group's feedback, suggest the need for investigating and developing such methods.

6

Concluding Remarks

This project aimed to construct and test a methodology for designing for the future, using the Truck and Trailer Industry as a case study in collaboration with Volvo Group. Thus, this project set out to answer the two research questions:

1. How may current trends impact future scenarios surrounding trailer and truck design?
2. Will the chosen method of scenario building produce a useful basis for design?

The scenarios themselves give an answer to the first question, though they are by no means certain predictions. Nevertheless, they were perceived as plausible by the participants consulted during the project. This input supports the credibility of the scenarios as a result.

The scenarios were also perceived as distinct yet simultaneously non-exclusive. This is likely an effect of mainly basing our scenarios on varying emphasis on megatrends, rather than catalysts. However, our findings suggest that focusing on catalysts is more thought provoking. As stated in the theoretical framework, many decision makers often emphasise catalysts as they develop more quickly. However, in discussion, the scenarios' non-exclusivity was considered to be an advantage as ideas originating from different scenarios could potentially be adapted to suit two or all predicted futures. This flexibility may be particularly beneficial for companies with long product development cycles that cannot alter their products quickly. As long as the scenarios meet the criteria distinctness, describing different developments, this type of methodology could possibly lead to secure investments in product development. Hence, our method of scenario construction could present an interesting alternative.

As previously stated, our results suggest there is a lack of existing tools for translating scenarios into products. Moreover, we found no criteria for scenarios that were specifically formulated to determine their applicability for design. While several criteria were applicable, they were more targeted towards policy-making and business. This could be because scenarios are more frequently researched and described in these contexts, rather than in design. One criteria found, which was not suited for this project, was decision-making utility (EFP, n.d.). Therefore, the formulation of criteria tailored to assessing scenario applicability in design could provide valuable

insights into how best to utilise scenarios in the design process.

To continue to develop this method, the next step could be to investigate the best method of transitioning from scenario to product. Especially, ways to create designs that incorporate and reflect the scenarios to a larger extent. As expressed by the group of designers, this is a challenging step. Therefore, exploring methods to better utilise developed scenarios in a cohesive process could be highly valuable, increasing the benefits derived from the work spent on creating scenarios.

While the feedback points out a weakness in the complete design process, it does not mean that the overall method used during this project has proven unsuccessful. During the project the group experienced that the selected methods supported the work of scenario construction well. While the problem of then utilising the scenarios' full potential needs further investigation, the scenarios themselves have been positively received and will be further utilised as a creative resource. We therefore draw the conclusion that the chosen method created a useful basis and tool for design, thus answering the second research question.

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