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Developing Interior Concepts for Long-Haul Truck Driver Well-Being

A Concept Development Project regarding Food-Related Features Inside the Truck Cabin.

Master's thesis in Product Development

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Cover: Image of the final concept modelled in CATIA v5.
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Abstract

Professional long-haul truck drivers face significant and well-documented health challenges linked to their profession, including sedentary work, irregular schedules, social isolation, and limited access to healthy food. Despite growing awareness of these challenges, the truck cab's food-related architecture has largely remained unchanged. This thesis investigates how food-related support features can be integrated into the truck cab to enhance the driver's well-being, focusing on long-haul truck drivers in Northern Europe.

The thesis was conducted in collaboration with the CAB Ergonomics team at Volvo Trucks and followed a structured product development process. A pre-study combining a survey and semi-structured interviews with long-haul drivers in Sweden revealed findings that fundamentally redirected the project. Contrary to the initial hypothesis where it was believed that the limited food-preparation capabilities of the interior truck cab had a negative impact on driver well-being, drivers expressed high satisfaction with existing cab appliances. Instead, the interviews consistently surfaced a different and more fundamental need to mentally and physically separate the act of driving from the act of resting. Drivers regularly moved to the passenger seat during breaks not necessarily because it was better suited for eating, but because it provided a psychological signal that work had paused. From the pre-study, eating habits were identified as the most prominent negative factor affecting well-being, yet the barriers were largely structural due to unpredictable schedules, parking shortages, and time pressure. The primary unmet need that was identified and followed in the thesis was therefore not a richer food preparation environment but a dedicated lounge space within the cab.

These insights directed the concept development toward reorganizing the cab interior rather than adding new technology. Through a structured product development process including morphological matrix generation, concept screening, and iterative evaluation with the Volvo Trucks CAB Ergonomics team, a winning concept was selected. The concept was modelled using Catia V5 and integrated into a virtual reality environment using VRED where ergonomic evaluations were performed. The final concept is an entirely new single-driver truck cab interior, consisting of a convertible rear bed configuration with an adapted dashboard preparation zone, an additional storage module, and a refrigerator in the dashboard. Together these elements create a coherent lounge and dining area physically separated from the driving position, addressing the central finding of the study.

The results demonstrate that meaningful improvements to driver well-being through in-cab food-related features are achievable, and that the transition toward a cab that feels like home represents a significant competitive opportunity for Volvo Trucks.

Keywords: Product development, long-haul truck, driver well-being, cab interior design, food-related features, ergonomics, concept generation, Virtual Reality

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List of Acronyms

Below is a list of acronyms that have been used throughout the thesis work report listed in alphabetical order.

AI - Artificial Intelligence
BOM – Bill of Materials
CAD – Computer Aided Design
Cab – Truck Cabin/Truck House
CVA – Competitor Vehicle Analysis
GDPR – General Data Protection Regulation
NDA – Non-disclosure Agreement
PCM – Pairwise Comparison Matrix
VR – Virtual Reality
RQ – Research Question

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1 Introduction

This master's thesis formed a part of the Department of Industrial and Material Science at Chalmers University of Technology. The thesis presents a comprehensive analysis of the challenges and opportunities related to the well-being of long-haul truck drivers. This project was conducted in collaboration with the CAB Ergonomics team at Volvo Trucks AB. With a focus on well-being related to food habits and associated activities inside the truck cabin, this collaboration aimed to improve the well-being of the drivers through exploring how in-cab solutions can better support healthier eating habits, comfort, and overall quality of life for professional truck drivers.

1.1 Background

The transport sector is a central part of modern society, providing a continuous flow of goods that support both economic development and people's everyday lives. Road transport is heavily dependent on professional truck drivers, whose work is frequently characterized by long hour shifts, irregular schedules, and poor working conditions (Kiss, 2025). These working conditions have raised increasing concerns regarding physical and mental well-being, as well as the broader implications for road safety and operational efficiency. In recent years, attention from researchers and industry stakeholders has shifted toward understanding how occupational demands within the transport sector influence health-related outcomes among drivers.

Concurrently, growing awareness of public health and sustainable working environments has highlighted the need for systematic effort to support well-being within transport professions. Factors such as sedentary lifestyles, limited access to healthy food options, and high levels of stress are commonly associated with long-haul trucking and may contribute to long-term health risk (Virgara et al, 2024). Addressing these challenges requires deeper understanding of the everyday practices and structural conditions that shape drivers' opportunities to maintain healthy habits.

Based on this context, the role of the vehicle manufacturer becomes central. For Volvo Trucks, the well-being of truck drivers using the company´s vehicles is a prioritized area. Volvo Trucks strives to provide premium driver environments that support both physical and mental health through maintaining high standards of ergonomics, safety, and design quality (Volvo Trucks, 2026).

Volvo Trucks portfolio consists of a wide range of vehicles designed for different areas, with the FH series being one of its core products. The FH model is a heavy-duty truck designed for long-haulage driving that comes in several different variants which can be tailored to the needs of the driver. A selection of these variants can be seen in Figure 1 below.

Figure 1. Modified product photo from Volvo Trucks showing different FH variants (Volvo Trucks, 2026b).

The size of the truck cab has a direct influence on the range of features and amenities available within the vehicle. A larger cab provides greater spatial capacity, as is evident when comparing European and North American truck models. This distinction can be illustrated by examining the largest Volvo truck models available in their respective markets: the Volvo VNL 860, sold in the United States and Canada, offers a notably larger living space compared to its European counterpart, the Volvo FH16, as shown in Figure 2 below.

Figure 2. From Volvo Trucks, the interior views of the Volvo VNL 860 and Volvo FH16 models (Volvo Trucks, 2026c; Volvo Trucks, 2026d).

This in turn allows for a broader selection of equipment and tools, while also offering an expanded living area for the driver. This is particularly relevant for long-haul drivers, who spend extended periods of time in their vehicles and therefore rely more heavily on the functionality and comfort that a larger cab can provide.

The increasing focus on well-being within the vehicle interior creates an opportunity to investigate how food-related support features can be integrated into the truck cabin. This thesis aims to support Volvo Trucks' ambition of creating a healthier and more sustainable driver environment by addressing the needs of professional truck drivers, all while staying in line with Volvo's design language and technical constraints.

1.2 Purpose

The purpose of the thesis project was to investigate the overall well-being of truck drivers, before narrowing the focus on food-related solutions for the truck cabin to support healthier eating habits. The project aimed to identify the driver's needs, wishes, and existing constraints related to food storage, preparation, and consumption inside the truck cabin.

1.3 Objectives

The objectives of this master's thesis were to deliver an overview of the factors affecting long-haul truck driver well-being and to develop an interior cab concept addressing food storage, meal handling, and eating comfort with the aim of enhancing driver well-being through a redesigned cab environment. The final solution is then set to be modelled in the Computer Aided Design (CAD) program CATIA V5 and evaluated in a Virtual Reality (VR) environment.

1.4 Delimitations of the Project

To ensure that the thesis work is not only completed but also kept within a reasonable scope for the given time frame, the following delimitations were defined.

The user study was based on a specific target group. This target group consisted of long-haulage truck drivers operating in Northern European countries where the Volvo FH model is used, with focus on first time buyers of the truck as habits often differs for second or third hand users (P. Björnström, personal communication, January 2026). Based on internal framework at Volvo Trucks, the final solution was adapted to males in the 50th percentile range, however outliers such as females of the 5th percentile and males of the 95th percentile ranges were also considered in ergonomic evaluations. The anthropometric measurements for the manikins were based on data from Högskolan i Skövde (n.d.), as to not disclose measurements from Volvo Trucks.

By the end of the thesis work, the deliverables consisted of a compilation of the results from the user study, a CAD model of the final concept, and an assessment performed in a virtual reality (VR) environment, not the production of a physical prototype. The results aimed to provide the department involved with a deeper understanding of truck drivers' needs and experiences, as well as to identify additional factors affecting their well-being beyond food-related aspects.

The thesis did not focus on quality-of-life improvements related to driving time and rest periods, as these are governed by EU regulations such as Regulation (EC) No 561/2006 (European Commission, 2006). Costs were also excluded in this thesis due to the conceptual nature of the result.

1.5 Definition of Research Questions

Research questions (RQ) were determined based on the background of the project, the purpose, and delimitations. To account for the wide scope of the thesis, a set of main research questions were defined with sub-questions that would also be investigated throughout the thesis. The following research questions were investigated:

RQ 1. How do truck drivers perceive the impact of their daily work on their well-being?

RQ 2. What are the current eating habits and food handling practices of truck drivers in the truck today?

RQ 3. What needs, wishes, and expectations do drivers have regarding in-cab food-related features?

1.6 Ethical Aspects

Several ethical aspects were identified and addressed throughout the thesis. Confidentiality was carefully managed through the signing of a non-disclosure agreement (NDA) with Volvo Trucks. While this measure ensured the protection of sensitive information, it also introduces a potential limitation, as the agreement may give rise to questions regarding the objectivity and impartiality of the research findings.

Data handling was conducted in accordance with the General Data Protection Regulation (European Parliament and Council of the European Union, 2016). All data collected through the interviews and survey were processed and stored in compliance with applicable regulations, ensuring the privacy and integrity of participant information.

Broader societal implications such as the value of improving driver well-being were taken into account. Healthier and more satisfied drivers are more likely to perform their work safely which carries direct implications for road safety beyond an individual level. As the thesis concerns a developing a concept directly affecting individuals in their daily lives, particular care was taken to consider the potential impact of the research on the target group by accounting for relevant legislation and user needs.

During the project, AI was used as a supporting tool in two different ways. Firstly, to transcribe interviews trough the built-in artificial intelligence (AI) feature in Microsoft Teams. Secondly, the chat AI from Volvo Group, to ensure the use of correct grammar and finding synonyms. Apart from these two instances, AI was not used in creating other materials for the thesis.

2 Methodology

The thesis followed an iterative product development methodology which combined qualitative and quantitative research methods with several different concept generation, development, and evaluation tools. The approach that was followed throughout the thesis ensured that the truck drivers' needs and wishes were identified and translated into requirements that acted as the foundation for the project. Evaluations in the form of elimination matrices to reduce the number of generated concepts, and ergonomic assessments to determine the usability and applicability of the concepts will be performed. The thesis work will follow the methodology described in Product Design and Development by Ulrich and Eppinger (2012) and follow structure showcased in figure 3.

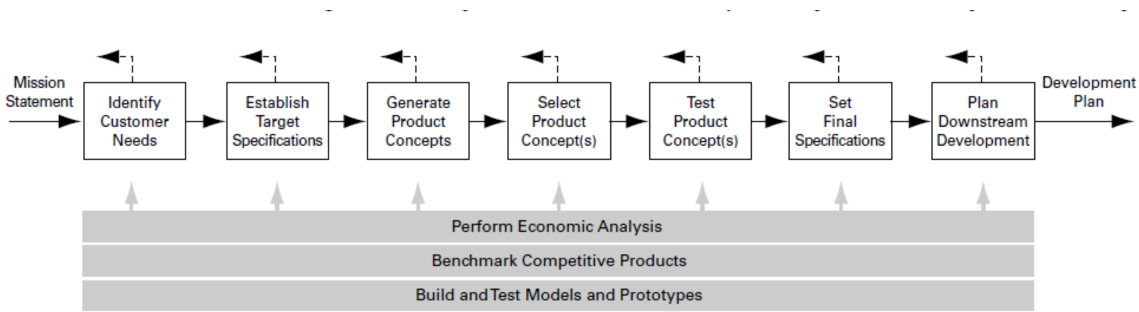


Figure 3. Product Development Process (Ulrich & Eppinger, 2012).

2.1 Pre-Study

The thesis began with a comprehensive pre-study to establish an understanding of the problem context, the user's needs, and external constraints such as legal requirements. The pre-study included a literature review, company & market analysis, benchmarking, and research regarding legal demands. Furthermore, user studies in the form of surveys and interviews with integrated observations, were conducted to confirm the results from the literature review as well as identify current user needs regarding the driver's well-being.

2.1.1 Literature Review

A literature study is a systematic review of existing research and publications within a given subject area, with the aim of establishing a theoretical foundation and identifying patterns or gaps in current knowledge (Snyder H., 2019).

During this thesis work, a literature review was conducted to build an in-depth understanding of the well-being of truck drivers, with a particular focus on long-haul drivers. The review was not limited to a specific geographic region but instead aimed to capture a broader perspective on how the nature of the occupation affects drivers' daily habits and overall health. This included an investigation into the potential correlations between the profession and various illnesses, such as the prevalence of smoking according to professionals at Volvo Trucks, which served to confirm the underlaying assumption that truck drivers tend to develop unfavourable habits as a direct consequence of their working conditions.

The literature review was based upon sources found through academic research platforms, such as Google Scholar and Science Direct, together with previous studies performed by internal organisations within Volvo Trucks.

2.1.2 Company & Market Analysis

A company and market analysis has been performed using two analytical methods: a SWOT analysis and a PEST-EL analysis. The SWOT analysis was performed to identify strengths, weaknesses, opportunities, and threats that directly impact Volvo Trucks. A SWOT analysis is a structured framework used to evaluate the internal and external factors affecting an organization, examining strengths and weaknesses as internal dimensions and opportunities and threats as external ones (CIPD, 2024). The PEST-EL analysis takes a broader look at the company by identifying risks and opportunities relating to political, economic, social, technological, legal, and environmental topics (Washington State University Libraries, 2023).

2.1.3 Benchmarking

To gain an understanding of how Volvo's competition handles the topic of driver well-being a benchmarking study has been conducted. The benchmarking study consists of a Competitor Vehicle Analysis (CVA) which was performed at Volvo Trucks. Benchmarking is a method described by Ulrich and Eppinger (2012) where competitor products are mapped and evaluated comparatively, an example is shown in Figure 4.

Metric No.	Need Nos.	Metric	Imp.	Units	ST Tritrack	Maniray 2	Rox Tahx Quadra	Rox Tahx Ti 21	Tonka Pro	Gunhill Head Shox
1	1, 3	Attenuation from dropout to handlebar at 10 Hz	3	dB	8	15	10	15	9	13
2	2, 6	Spring preload	3	N	550	760	500	710	480	680
3	1, 3	Maximum value from the Monster	5	g	3.6	3.2	3.7	3.3	3.7	3.4
4	1, 3	Minimum descent time on test track	5	s	13	11.3	12.6	11.2	13.2	11
5	4	Damping coefficient adjustment range	3	N-s/m	0	0	0	200	0	0
6	5	Maximum travel (26-in. wheel)	3	mm	28	48	43	46	33	38
7	5	Rake offset	3	mm	41.5	39	38	38	43.2	39
8	6	Lateral stiffness at the tip	3	kN/m	59	110	85	85	65	130
9	7	Total mass	4	kg	1.409	1.385	1.409	1.364	1.222	1.100
10	8	Lateral stiffness at brake pivots	2	kN/m	295	550	425	425	325	650
11	9	Headset sizes	5	in.	1.000 1.125	1.000 1.125 1.250	1.000 1.125	1.000 1.125 1.250	1.000 1.125	NA
12	9	Steertube length	5	mm	150 180 210 230 255	140 165 190 215	150 170 190 210	150 170 190 210 230	150 190 210 220	NA
13	9	Wheel sizes	5	List	26 in.	26 in.	26 in.	26 in. 700C	26 in.	26 in.

EXHIBIT 6-6 Competitive benchmarking chart based on metrics.

Figure 4. Exhibit 6-6, Competitive benchmarking chart based on metrics. (Ulrich & Eppinger, 2012).

In the CVA, truck models that compete with Volvo's largest offering, Volvo Trucks FH16 Aero XXL were investigated and analyzed to identify differences and similarities between the competitors' truck cabin interiors. The benchmarking was performed through looking at competitor vehicles available at Volvo Trucks that are suitable for long-haul driving in-person and comparing the offering of relevant features across different brands. Throughout the benchmarking analysis a focus was put on identifying the different truck models in-cab storage opportunities, food-related support features, and the related dimensions. Outside of in-person evaluations, complementary photographs and videos from the internet have been used.

2.1.4 Patent Search

A patent search has been conducted using Espacenet (European Patent Office, 2026) to identify existing solutions related to food-related support features, innovative cabin layouts, and space utilization. The purpose of the patent search was to explore technical solutions to gain inspiration and reduce the risk of infringement on existing patented solutions that are still valid. The patent search was performed in two stages, beginning with a broad keyword search which gave an overview of the available patents but generated tens of thousands of results. The second step was therefore to limit the number of results using Classification search through the Cooperative Patent Classification (CPC) system.

2.1.5 Legislations

Legislation related to the truck cabin interior that could be impacted by concepts that alter the cab interior have been analyzed to find legal requirements that affect any of the potential future concepts. The legislation serves as a foundation for the requirement specification, ensuring adherence to legal requirements.

2.1.6 Survey

Surveys are a quantitative method that involves systematically collecting data by asking standardized questions to a sample of individuals. By analyzing the respondents' answers, the researcher can identify patterns and tendencies within the sample, which are then used as a basis for drawing conclusions and generalizing the results to a larger population (Goodfellow, 2023). The strength of the method thus lies in its ability to capture perceptions, behaviours, or conditions of a broad group of individuals in a structured and reproducible way.

An online survey was used as a quantitative data gathering method to collect data in the pre-study phase of the thesis work. The survey, which consisted of a questionnaire, was sent out to a wider audience in the form of general types of truck driver instead of solely the target group. The questionnaire explored the general well-being of the truck drivers through self-assessment of different factors related to how their mental and physical health is affected by them.
To reach the intended target group, relevant groups and forums on multiple social media platforms were used to spread the survey. To further increase the chance of the response rate, the survey was sent out to various teams with customer contact at Volvo Trucks as well as truck haulage companies to send to their truck drivers.

The questionnaire followed the General Data Protection Regulation (GDPR) (Regulation (EU) 2016/679, 2016). This meant that no personal data was requested, apart from a voluntary email sign up in case of interest of participating in an interview. The questions were designed as to not reveal any personal identifiers such as medical history. Additionally, the respondents chose to comply to have their data saved up until the 6th of June 2026 and was deleted accordingly.

2.1.7 Interviews

Interviews are one of the most widely used methods in user studies and aim to collect qualitative data through structured, semi-structured or unstructured conversations (Baxter, et al., 2015). The method enables a deeper understanding of users' experiences, behaviours and needs in specific contexts. In this pre-study, semi-structured interviews were used as the primary method to investigate how the target group's eating habits affect their well-being, what challenges occur and how food-related activities are handled in the truck cab. The method was chosen because it provides flexibility to follow up on relevant insights while ensuring that central themes are addressed systematically (Adeoye-Olatunde & Olenik, 2021).

Prior to implementation, the study's objectives, choice of interview type and an overall plan for data analysis were defined, based on established guidelines by Baxter, et al. (2015). An interview guide was then designed with relevant questions linked to the research questions. The guide was tested in a pilot interview with an external participant to evaluate the clarity of the questions, the length of the interview and identify the need for reformulation or removal of questions (Baxter, et al., 2015). The interviews were structured in five phases: introduction, warm-up, main part, cool-down, and conclusion.

A total of ten semi-structured interviews were conducted with long-haul drivers primarily active in Sweden, containing the same GDPR principles as in the survey. Eight of these were conducted digitally via video calls, with a gender distribution that reflected the results from the initial survey study where three out of ten interviewees were female. These interviews took on average 45 minutes to perform, featuring a set of 22 pre-determined questions with relevant follow-up questions depending on the necessity and situation. Two additional interviews were conducted on site at Stigs Center, where the interview guide was adapted to focus on the most central questions within a limited time frame. During all interviews, the conversations were supplemented with observations of the work environment in the truck cab. Participants were asked to describe and demonstrate how they used their surroundings in food-related situations to gain an understanding of how they differed from person to person and depending on the truck they drove. This contributed to a more contextual understanding of their behaviors and needs.

2.2 Customer Needs Analysis

A customer needs analysis was carried out based on the insights gained from the pre-study to uncover needs, wishes, demands and frustrations related to food-related support features in the truck cabin.

2.2.1 Data Analysis

To analyze the data gathered from the interviews, three main methods were used to identify and translate the latent and explicit customer needs and identify problems that the interviewees had related to the truck cabin interiors. Additionally, information related to their food habits and general well-being was gathered and analyzed through the following method to ensure that the generated concepts align with the wants of the target group. In line with Ulrich and Eppinger's (2012) distinction between latent and explicit customer needs, explicit needs were directly expressed by the participant as a desired feature or improvement while latent needs were those not directly stated but derived from patterns, workarounds, or expressed frustrations.

2.2.1.1 Thematic coding

Using Thematic Coding, interview responses were systematically coded across four categories following a thematic analysis approach as described by Braun & Clarke (2006). Each thematic code was assigned a prevalence score based on how many of the ten interviewees raised the same issue, and a priority weighting of high, medium, or low based on frequency and emphasis. This approach allowed individual statements to be traced back to specific participants, enabling comparison across demographic groups and driving contexts.

2.2.1.2 KJ-analysis

A KJ-analysis was performed by extracting statements from the interview transcripts and grouping them into thematic clusters based on shared meaning and user concern (Kawakita, 1982). The method involved writing each statement on a separate card and iteratively grouping cards by affinity until stable clusters emerged where each card was grouped with a descriptive theme title. Unlike the narrower thematic coding, the KJ-analysis operates at the cluster level, revealing how individual statements fit into broader topic areas and highlighting which themes generated the most participant engagement across the sample (Scupin, 1997).

2.2.1.3 Gioia Coding

A supplementary method called Gioia Coding was used to further contextualize and interpret the data from the interviews, and more specifically to make it easier to interpret the KJ Analysis. The Gioia methodology is a systematic approach where data is analyzed across three levels, first order concepts, second order themes, and aggregate dimensions (Gioia, 2013). The use of Gioia Coding aids in visualizing the data from the interviews through not only highlighting important points as in the KJ Analysis but also grouping them together in different levels. The method is especially useful to ensure a more transparent and traceable analysis where interpretations stem from the gathered data rather than prior assumptions. The analysis began with first order concepts constructed using quotes from the interviews that were used in the KJ-analysis, without theoretical interpretation or contextualization. These were then grouped into second order themes, where rather than labelling a cluster with its subject matter alone (e.g. “water and hygiene”), each theme was formulated as a contextual statement capturing why the pattern found from the interview quotes matter. This structure ensures that themes carry weight rather than functioning as descriptive category labels. Lastly, the second order themes were grouped into aggregate dimensions consisting of a further contextualization of the lower levels.

2.2.1.4 Ishikawa Diagram Analysis

A Cause-and-effect analysis as described in Ulrich and Eppinger (2012) has been performed in the form of an Ishikawa diagram, also known as a fishbone diagram. The Ishikawa Diagram is a graphical tool used to map and identify various causes which contributed to a defined effect which is especially valuable in the form of problem analysis and structured ideation (Li & Lee, 2011). The diagram which resembles the skeleton of a fish consists of a central horizontal spine leading to the effect node, in this case enhancing driver well-being. Angled branches extend from the spine which represent categories of causes. Within each branch, sub-causes identify specific contributing factors at a more detailed level. The Ishikawa diagram was applied as a final step as part of the customer needs analysis with the intent of building on the problems and barriers identified in the thematic coding. Unlike the previous methods that operated at different levels such as clustered statements or individually coded statements, the Ishikawa diagram serves a different and complementary purpose. It presents all identified causes in relation to a single defined effect, making the root cause structure of the problem-space explicit and traceable for the concept development phase. The categories used in the Ishikawa diagram differ from those in the KJ-analysis and Gioia Coding, as this representation functions as a broader compilation of all collected data rather than a sole focus on customer needs.

2.2.2 Personas

Personas are defined as fictitious, specific, and concrete representations of target users, serving as hypothetical archetypes that cluster the behavioural characteristics and attitudes of real users (Pruitt & Adlin, 2006). Personas were considered an appropriate method as they provide a structured way of translating gathered user data into tangible representations, allowing the design process to remain grounded in real user needs and expectations (Miaskiewicz, et al., 2011). Rather than relying on the characteristics of specific individuals, personas enable a broader perspective by synthesizing common patterns across multiple respondents, reducing the risk of designing for edge cases.

As part of the customer needs analysis, personas were developed based on data collected through the survey and interviews. The personas were constructed by identifying recurring features, opinions, and behavioural patterns among the respondents, which were then synthesized into three fictive user representations. These personas were subsequently used to contextualize the customer needs gathered throughout the study, guiding the product development process to ensure that proposed concepts aligned with the expectations and conditions of the target group.

2.2.3 User Journey Mapping

User journey mapping is a structured methodology for documenting and analysing the needs, emotions, and tasks of users throughout their interaction with a product or service (Kate Kaplan 2023). By charting an end-to-end experience, the user journey mapping method provides a comprehensive representation of how a specific user or user group engages with a system at each stage of interaction. Rooted in the broader principle that design must account for human cognition and behaviour (Norman, 1988), user journey maps serve both as an analytical and communicative instrument. They enable practitioners to systematically empathise with the user (Lanius et al., 2021), ensuring that design decisions are meaningfully informed by user needs and aspirations. Furthermore, user journey maps fulfil an important function in conveying the intended user experience to diverse stakeholders, offering a holistic overview of the design. As such, user journey mapping constitutes a foundation tool within user-centred design practice, facilitating a deeper understanding of the user and supporting the development of products and services that are more precisely tailored to their requirements (Eggink et al., 2020).

Based on one of the created personas, a user journey map was created to gain deeper understanding within the scope of the specific interactions related to eating habits during a standard work week. The map included different actions, thoughts and the emotional changes during the actions, as well as objects the user interacted with. From these user journey map categories, an analysis could be made over pain points and opportunities which furthered the concept generation process.

2.2.4 Customer Needs List

A customer needs list has been created based on analyzed data from the pre-study, mainly consisting of data from the survey and interviews. The customer needs list contains identified needs and wishes and has been used as a means of ranking them. The customer needs analysis follows the process described by Ulrich and Eppinger (2012) where raw data from the pre-study was gathered and translated into need statements. The needs were then organized and ranked by relative importance using a scale of 1-5 based on the frequency and the statement’s perceived importance in the pre-study. The needs were finally reflected upon in relation to the project scope, ensuring that they are related to enhancing the driver well-being through food-related support features. Need statements were formulated following the guidelines set by Ulrich and Eppinger (2012), ensuring that they express what the solution must do rather than how it must do it. Using this formulation of the need creates maximum flexibility for the subsequent concept generation phase and how the needs can be interpreted into tangible solutions.

2.3 Requirement Specification

A requirement specification has been created based on the identified customer needs from the pre-study and based on internal requirements for the cabin interior. The specification covers functional, ergonomic, safety-related, and design-oriented requirements, among others. The identified requirements serve as evaluation criteria in the concept generation and development phases, acting as the foundation for which the concept screening process is based on.

2.4 Concept Generation Methods

The concept generation phase was based on Ulrich & Eppinger's "Product Design & Development", 4th edition. Initial idea generation was performed in three main steps, starting with brainstorming, then brainwriting, followed by a co-creation workshop together with experts from the CAB Ergonomics team. The use of brainstorming allowed for great output of several ideas in a free and limitless way. Evaluations of the early ideas were performed with members of the CAB Ergonomics team in a semi-structured co-creation workshop, allowing for early feedback on ideas. In the idea generation phase solutions from other relevant industries such as sail boats and Recreational Vehicles (RVs) have also been explored. These areas were chosen to identify ergonomical and space-efficient solutions that could be applied to truck cabins as they feature similar requirements about safety and space usage.

A function analysis was performed, where key functions were identified and sorted by using a function tree diagram. The function tree diagram consists of a main function which branches off into sub-functions, giving a clear picture and traceability from the bottom-level to the top-level. After these initial stages of concept generation, the requirement specification was reviewed to ensure the fulfillment of the set requirements.

In the final step of the concept generation phase a Morphological Matrix, also known as concept combination table was used (Ulrich & Eppinger, 2012). The Morphological Matrix was used to generate concepts through different combinations of the identified functions, allowing for a greater variation in new concepts than through idea generation alone.

2.4.1 Brainstorming and Brainwriting

Brainstorming is a method which can be performed either individually or in groups to foster creativity which can lead to ideas or finding solutions to problems (Wilson, 2013). Brainstorming is a flexible method with broad applicability that can be adapted to different contexts and purposes but builds upon a common formal underlying structure: presenting the problem, trying to come up with ideas to solve the problem, followed by discussion of the ideas (Northern Illinois University, 2012). Brainwriting, much like brainstorming, is a method to generate ideas but this time the ideas are sketched out before discussion (Usability Professionals Association, 2010).

Brainstorming and brainwriting were chosen as the primary methods for generating ideas. These techniques allowed for creative flow without judgement or limitations. Based on the customer needs identified through interviews and the survey, a brainstorming session was conducted in which ideas were documented on post-it notes and subsequently grouped according to the identified problems. Once a comprehensive understanding of the potential solutions had been established, a brainwriting session was carried out, during which the ideas were sketched to visualize individual interpretations of the concepts generated in the brainstorming session. Additional ideas were also introduced during this phase.

2.4.2 Co-creation Workshop

Co-creation, or co-design, is a method in which designers collaborate with people who are not trained in design to jointly develop ideas and solutions. According to Sanders & Stappers (2007), co-design means that the creativity of both designers and users is integrated into the design process. The method represents a shift from traditional user studies, where the researcher mainly observes and interviews, to a more participatory and inclusive way of working. Co-creation can also be understood as a mindset, a method, and a tool depending on its application in the process (Wallgren, 2025). In this study, the method was used to enable value creation through active participation from relevant actors (Jansen & Pieters, 2017).

The method was chosen to capture insights from people with experience and expertise in the field, especially around problems and needs identified in previous studies and interactions with drivers. By involving participants in a creative process, opportunities were created to explore ideas that would otherwise not have emerged through interviews or observations alone. Co-creation also helps to stimulate participants' imagination and engagement, which can lead to more innovative and user-centered solutions.

The co-creation workshop was conducted based on principles from the Advanced User Studies and Co-creation course at Chalmers University of Technology (Wallgren, 2025). The workshop involved people with relevant experience who were actively involved in the idea development process. The approach focused on creating an open and creative environment where participants could share insights, discuss problem areas and jointly generate solution proposals. The method was thus used not only to collect data, but also as a tool for joint value creation, where the participants' perspectives were directly integrated into the design process.

2.4.4 Function Analysis

A Function Analysis in the form of a Function Tree Diagram has been performed based on the findings of the Customer Needs Analysis in chapter 2.2. The structure of the Function Tree Diagram is inspired by the enhanced function-means model described by Müller et al. (2019), organizing a design problem by separating function requirements from the design solutions that fulfill them, see Figure 5.

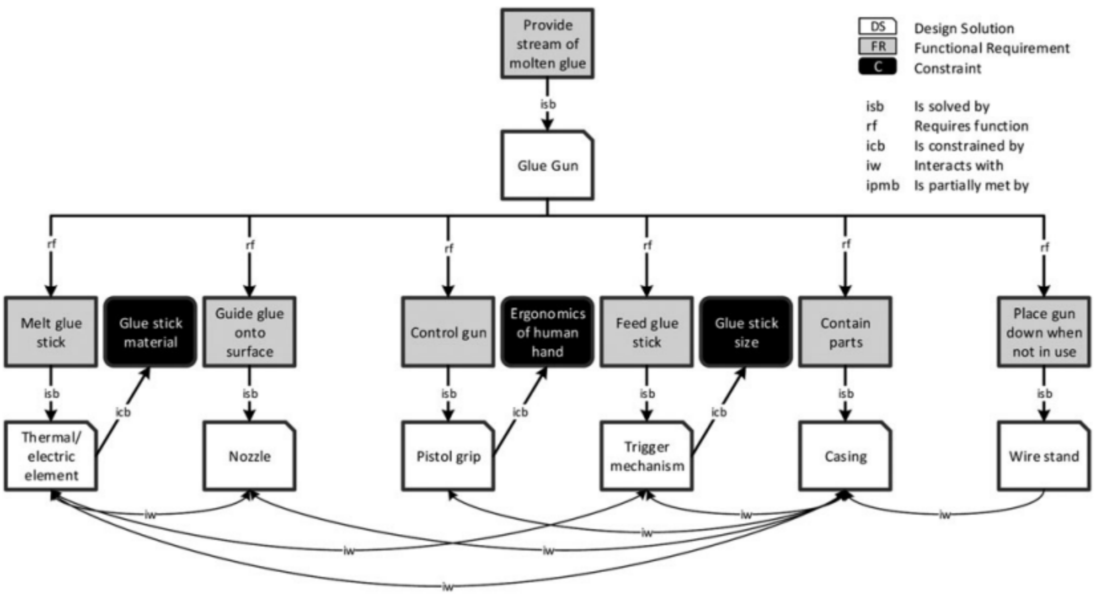


Figure 5. Enhanced Function-means model (Müller et al., 2019).

This approach enabled a more systematic and varied exploration of the design space which was complemented by the concept classification tree as described by Ulrich and Eppinger (2012). The combination of these two methods provided a structure for breaking down a design problem into sub-problems that could be explored and solved separately before being recombined into new concepts, see Figure 6.

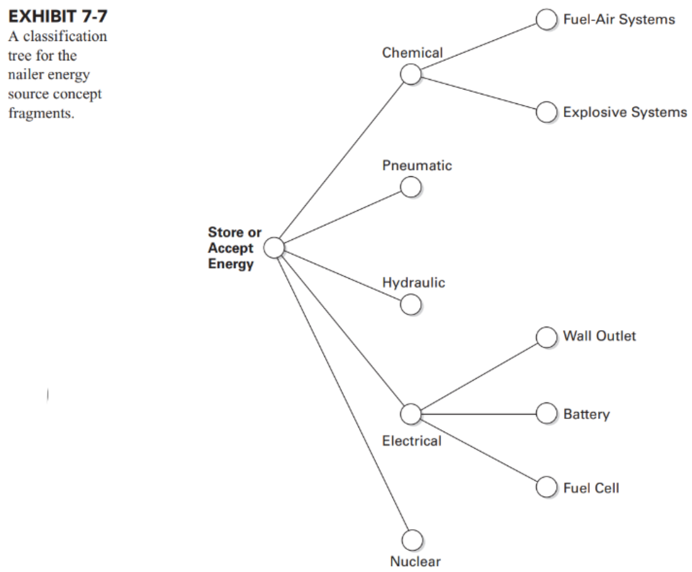


Figure 6. Exhibit 7-7, concept classification tree (Ulrich & Eppinger, 2012).

The function tree diagram contains the three-level hierarchy found in the function-means diagram but adapts the terminology to better reflect the nature of the identified problem by using main function, sub-functions, and sub-solutions. As described by the concept classification tree from Ulrich and Eppinger (2012), the sub-functions are treated as independent dimensions of the design space rather than functional requirements, whereas their respective sub-solutions more closely resemble the design solutions. In contrast to Müller et al. (2019), constraints were omitted from the function analysis and rather introduced in the subsequent concept screening phase. The main function, and sub-functions were derived directly from the customer needs analysis, corresponding to a cluster of identified customer needs and wishes grouped together. The sub-solutions found under each sub-function were then generated to address the identified needs using existing and conceptual solutions derived from wishes, requirements, and benchmarked competitor solutions. This approach ensured that the function tree was grounded in real user needs rather than the assumptions that had been made prior to the customer needs analysis.

2.4.5 Morphological Matrix

The morphological matrix was used as the concept generation method for this project, following the concept combination table described by Ulrich and Eppinger (2012), see Figure 7.

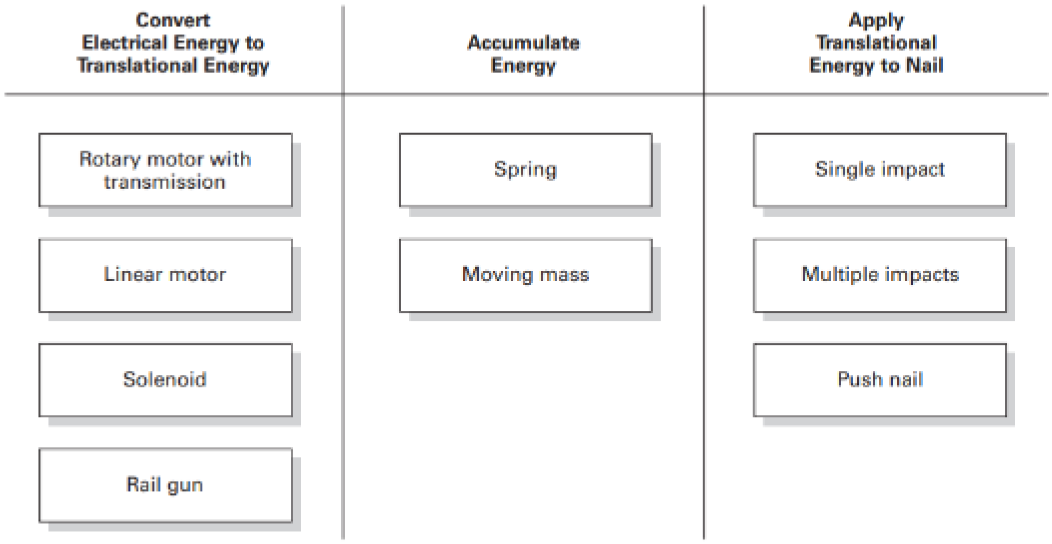


EXHIBIT 7-9 Concept combination table for the handheld nailer.

Figure 7. Exhibit 7-9, Concept combination table (Ulrich & Eppinger, 2012).

A morphological matrix, or combination table as it is also called, is a structured grid in which each row represents a sub-function and each column position represents one possible sub-solution for that sub-function. Complete concepts are generated by selecting one sub-solution from each row and combining the selections into a single configuration. This approach ensures that the design space is explored combinatorially rather than intuitively, ensuring that viable configurations are not overlooked. Rather than generating a physical component part of single products, the morphological matrix was instead used to generate interior cab layouts based on the identified sub-functions and sub-solutions. Each generated concept therefore represents a complete spatial configuration of the cab interior rather than a variant of a single component, more closely aligning with the scope of the design problem and thesis. This application is consistent with the broader purpose of the combination table as described by Ulrich and Eppinger (2012), which is to enable systematic exploration of a large design space through structured combination rather than manual or sequential ideation.

To manage the generation and tracking of combinations, the web-based software tool Morpheus was used (Martinsson Bonde, 2021). Morpheus is a software tool developed to improve the applicability of morphological matrices in engineering design and was demonstrated to ease the process of creating and modifying morphological matrices (Martinsson Bonde et al., 2022). The sub-functions and sub-solutions from the function tree analysis were entered directly into the tool, which then computed all valid combinations. An important practical consideration noted in the literature is that digitalizing and automating methods that have traditionally been conducted manually can have unintended side effects, and students who used Morpheus were found to focus on quantity over quality when generating concepts. To mitigate the risk of prioritizing quantity over quality when generating concepts, a structured incompatibility identification process was performed to limit the amount of concepts generated. This was done by systematically going through the sub-functions and their corresponding sub-solutions to identify which would clash with each other and if any of the sub-functions were unfeasible to include at all.

2.5 Concept Selection Methods

In this chapter, the methods followed throughout the concept selection process will be described in detail.

2.5.2 Elimination Matrix

Following the concept generation stage and the evaluation of concept categories, a concept screening phase was performed to reduce the number of concepts to a manageable number of candidates before comparative evaluation. The Elimination Matrix used to reduce the concepts is based on the systematic selection chart described by Pahl and Beitz (1996), which provides a structured approach to eliminating unsuitable proposals from a large solution field, see Figure 8.

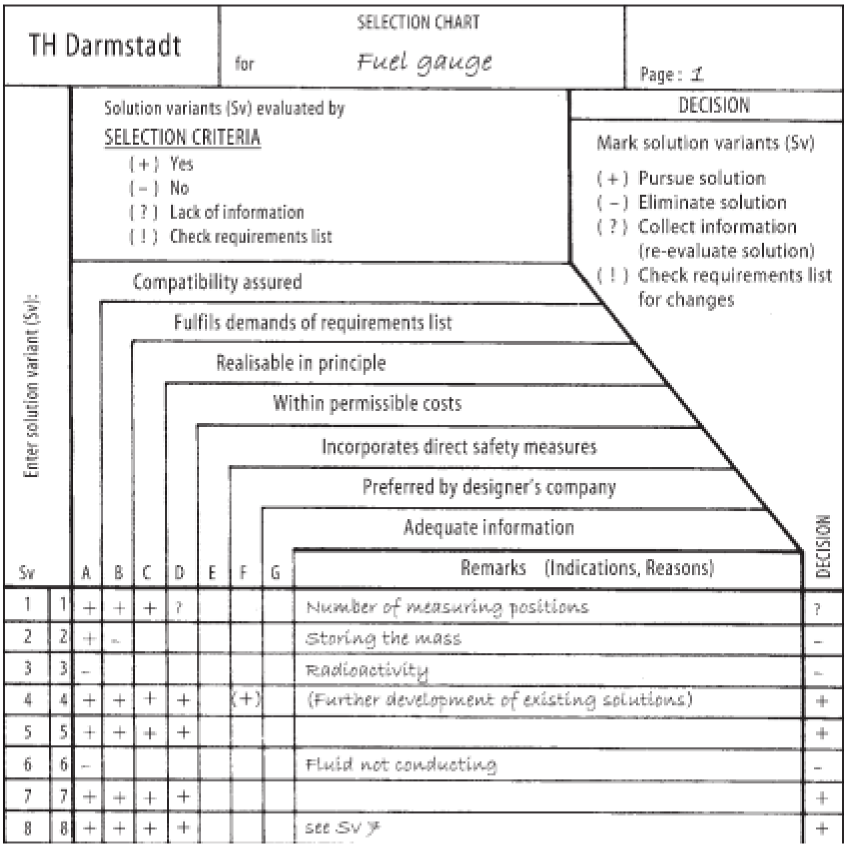


Figure 8. Systematic selection chart for eliminating solution variants. Adapted from Engineering Design: A Systematic Approach (p. 108), by G. Pahl and W. Beitz, 1996, Springer. Copyright 1996 by Springer-Verlag London Limited. Adapted with permission.

The selection chart works by applying a set of criteria sequentially to each concept. If a concept fails any of the criteria, it is eliminated and no further criteria need be applied to it. Four primary selection criteria are defined in the selection chart that are applicable to all solution variants:

- Compatibility with the overall task and with one another
- Fulfilment of the demands of the requirements list
- Realizability with respect to performance and layout
- Compliance with permissible cost boundaries

In this project, six alternate criteria were applied that were based on the four original criteria but derived from the customer needs and wishes identified in the pre-study. These criteria were then structured and used as a guide to pass or fail concepts following the yes or no logic described by Pahl and Beitz (1996) based on how well each concept and their sub-solutions fulfilled the criterion. The criteria used and their descriptions are showcased in table x.

Table 1. Criteria used in the Elimination Matrix.

Criteria	Description
Lounge quality	Assessed whether the concept creates a spatial separation between the driving position and a dedicated rest and eating zone
Ergonomic usability	Assessed whether the sub-solutions in the concept can be used without problematic body postures or constrained access across the F05 - M95 anthropometric range
Food handling capability	Assessed whether the concept meaningfully supports the food handling capability required in the cab, relating to storage, heating, and eating
Implementability	Assessed realizability of the layout within the cab architecture available in Volvo's long-haul trucks and compliance with safety and regulatory requirements
Storage Efficiency	Assessed whether the storage sub-solution provides adequate volume without creating access conflicts
Spatial Efficiency	Assessed whether the concept makes efficient use of available cab space without physical obstructions

2.5.3 Pugh Matrix

The Pugh matrix, referred to as the concept selection matrix in Ulrich and Eppinger (2012), was used as the next concept screening step to comparatively evaluate the remaining concepts against a reference concept across a fixed set of criteria. The method, developed by Pugh (1981), assigns each concept a score using better than (+), the same as (0), or worse than (-) the reference for each criterion. The total score is then calculated as the number of positives minus the number of negatives and ranks concepts relative to the reference, which is then replaced by the highest scoring concept at the end of each iteration. This iterative approach allowed the reference to progressively represent the best-known configuration rather than a fixed baseline.

In total, three iterations of the Pugh Matrix were performed. The first iteration used the current Volvo FH16 Aero XXL production cab as the reference, establishing the baseline performance against which all concepts were compared. The second and third iterations used the winning concepts for each respective iteration. All concepts were evaluated against a set of ten criteria that were based on the identified customer needs. The criteria and their description can be found in table x.

Table 2. Criteria used in the Pugh Matrices.

Criteria	Description
Perceived lounge quality	Does the concept create a clear, coherent living space that feels distinct from the driving position
Driver adoption	How likely are drivers to enjoy and want to use the new lounge-focused layout and does it require a learning period or is everything clear from the start
Resting configuration	How flexible is the seating arrangement for different activities such as eating, resting or socializing

Ease of drive-to-rest transition	How quickly and intuitively can the driver convert the cab from driving mode to rest or lounge mode
Complexity of construction	How complex and difficult to set up are the different sub-solutions when combined in a cab layout
Meal preparation capability	Does the meal preparation zone sub-solution provide a genuinely usable surface for basic food handling
Eating space quality	How well does the eating surface sub-solution support stable, comfortable eating in a lounge context
Storage capacity	How much total storage capacity does the concept provide across all sub-solutions
Cold storage capacity	Does the cold storage sub-solution meet the needs of a full working week
Walkthrough clearance	How unobstructed is the path between the driver seat and the rear sleeping/lounge area

2.5.4 Kesselring Matrix and Pairwise Comparison Matrix

Concept scoring is applied when a higher level of resolution is required to differentiate between competing design concepts more effectively (Ulrich & Eppinger, 2012). The Kesselring matrix is a version of concept scoring matrix (Ulrich & Eppinger, 2012), which applies weighted factors and grading scales to enable a structured comparison of the remaining concepts to an optimal reference. In the Kesselring matrix, the weighted factor of each criterion is determined by using a pairwise comparison matrix (PCM). PCM is a method based on comparing criteria or tasks in pairs based on their relative importance to a reference (Kyne, 2026), to reduce the risk of subjectivity and increase the precision of the weighting.

The Kesselring matrix was applied during the final phase of the concept screening process, to determine which concepts would be further evaluated. The pairwise comparison allowed for identification of which criteria were perceived as the most important based on the different personas as well as opinions of the experts at Volvo Trucks since a reference element did not exist. In addition to the weighted factors, the individual components of each concept, such as different table configurations, were evaluated by directly comparing them against one another for each criterion. For example, when assessing accessibility, each configuration was ranked relative to the other. Based on these comparisons, each configuration was assigned a corresponding score for that specific criterion, which in turn ensured a fair and consistent grading of each concept.

2.5.5 Final Concept Selection

The final concept selection was based on defining “Pros and Cons” with the concepts which remained after the Kesselring Matrix together with the CAB Ergonomics team at Volvo. The method was described in Product Design and Development by Ulrich and Eppinger (2012) as a means to select the final concept after performing concept screening. A presentation detailing the different concepts along with background information was given to the team to ensure proper understanding of the concepts among the members of the team. Team members were given time after the presentation to think about strengths and weaknesses with each of the concept’s layout types and sub-solutions. Finally, the concepts identified strengths and weaknesses were written down on post-it notes and gathered before being evaluated to determine which concept to further develop.

3 Results of the Pre-Study

In this chapter, the results of the pre-study that was performed in the thesis work will be displayed.

3.1 Literature Review

Truck drivers are a central part of society's infrastructure, but their working conditions and living situation rarely receive the same attention as the importance of the profession. In recent years, questions about how work affects drivers' well-being have become increasingly relevant, leading to a growing interest in understanding the challenges and conditions that characterize their everyday lives. According to available research, truck drivers face a number of significant health risks that are largely linked to the sedentary nature of the profession, irregular working hours, and the psychosocial strain that the work entails. The work is often characterized by long driving shifts, limited opportunities for recovery, and social isolation, which together create unfavorable conditions for both physical and mental health.

To put the issue in a broader perspective, a study by Cedefop (2023) shows that there were around 8.2 million professional drivers in the EU in 2022, of which around half were drivers of long-haul trucks and buses. The same report predicts a decline in the number of vehicle drivers by 2035, indicating a future skills and labor shortage in the transport sector (Cedefop, 2023). This development is also confirmed by Costello et al. (2017), who argue that the trucking industry has had an ongoing driver shortage since 2005. The reasons were described as being linked, among other things, to the demographic composition of the profession in terms of age and gender, but also to the lifestyle and working conditions that come with the profession (Costello et al. 2017).

From this background, the well-being of truck drivers appeared to be a central prerequisite for the long-term sustainability and attractiveness of the transport industry. A literature study by Crizzle et al. (2017) demonstrated clear connections between several of the risk factors that characterize the work and life situation of long-haul drivers, such as smoking, obesity, poor diet, low physical activity, stress and insufficient sleep. It also showed an increased incidence of medical conditions such as diabetes and cardiovascular diseases in both the United States of America (USA) and Canada. The results indicate that these health risks cannot be understood in isolation, but rather as an interaction between individual lifestyle habits and the structural conditions of the profession (Crizzle et al., 2017).

Research compiled by Virgara et al. (2024) confirmed that truck drivers constitute an occupational group with significantly increased health risks compared to the general population. The profession is characterized by prolonged sedentary work, limited opportunities for physical activity, irregular working hours and lack of access to healthy food, which together create an environment that makes it difficult to adopt health-promoting behaviors. These structural conditions have led to unhealthy lifestyle habits, such as low physical activity, energy-dense diet, smoking, high alcohol consumption and insufficient sleep, being particularly prevalent among drivers. The study also showed that cardiometabolic problems are very common in the occupational group. According to Virgara et al. (2024), truck drivers exhibit high levels of overweight and obesity, which was supported by internal data from Volvo Trucks, and there was an increased incidence of hypertension, hypercholesterolemia and elevated blood sugar. This unhealthy profile was reinforced by shift work and sleep deprivation, which have long been known risk factors for both cardiovascular disease and metabolic disorders. In addition to the medical consequences, the authors also highlighted broader safety aspects. There was evidence that obese drivers are at higher risk of being involved in road accidents, making health an issue that affects both the individual and public road safety. Despite this, it was noted that existing health interventions are often limited and mainly focus on individual responsibility, rather than on the work environment and organizational factors that largely shape drivers' behavior (Virgara et al. 2024).

This perspective was further developed when analyzing an earlier study conducted by Bschaden et al. (2019) where food patterns for long-haul truck drivers were investigated. The results were based on a survey with 404 long-haul drivers along the autobahn in Germany, with around a third being of German nationality and approximately half of the participants having nationalities from eastern-European countries. The study showed that the vast majority were considered overweight or obese and Bschaden et al. (2019) stated “in regard to their health, more than half reported that they smoked and 32% reported at least one chronic disease”. The study concluded that there are clear distinctions between eating habits while working in contrast to when off work. The consumption of energy drinks, sausage produce and canned goods increased, whilst foods such as fish, dairy products and fresh vegetables decreased while on tour. However, the study showed no major differences in eating habits when comparing high BMI drivers to average BMI drivers, though the amount of consumed food was not an included/considered factor. In addition, the availability of food related appliances appeared to support healthier eating habits due to the lack of healthy options at truck stops or restaurants. The authors also emphasized that in addition to behavioral interventions and healthier food at truck stops, it is important to develop vehicle cabins with improved solutions for cooking, storage, and meal preparation to promote a more balanced diet (Bschaden et al., 2019).

A similar study was conducted by Ruettger et al. (2025) regarding the potential barriers of healthy food choices for long-haul truck drivers in the United Kingdom (UK). The study was based on ten semi-structured interviews, of which eight being male, and previous research. From the interviews, it emerged that drivers' lifestyles were often characterized by limited access to nutritious food and structural conditions, for example restricted food storage in the truck cabin, that hinder healthy habits. Which aligns with the conclusions drawn by Bschaden et al. (2019), that the nature of professional truck driving creates challenging working conditions that make it difficult to maintain a healthy lifestyle, and appear to have a direct impact on the food choices drivers make while on the job.

Lise et al. (2024) investigated how long-haul drivers experience truck stops and rest areas from a health and well-being perspective in Brazil. The study presented that factors such as limited access to nutritious food, insufficient opportunities for recovery, and perceived insecurity in the work environment have a direct impact on the drivers' lifestyle and health. However, the results indicated that the truck drivers perceived the services of food and rest at truck stops as good or excellent, whilst services related to personal hygiene, physical activity and perceived safety showed need for improvement (Lise et al, 2024). This points to a contradiction between the general research picture of unhealthy living conditions and the drivers' own experiences in the current context. The results therefore emphasize that drivers' health is largely shaped by the environments and organizational frameworks within which the work is performed, and that there is a need for more structurally oriented health-promoting initiatives that consider both objective conditions and subjective experiences.

Another identified area that is a particularly serious problem within the occupational group is mental health. According to a study performed by da Silva-Júnior et al. (2009), showed that truck drivers are at increased risk of developing depression compared to the general population. Increased vulnerability has been linked primarily to low levels of education, precarious employment and the use of stimulants to cope with long work shifts. Work-related stress, time pressure and lack of control over the work situation are described as central underlying mechanisms, and these factors are reinforced by the loneliness that often characterizes long-distance driving (da Silva-Júnior et al., 2009).

3.2 Company and Market Analysis

The company and market analysis provided an understanding of Volvo Trucks' position in the current European market compared to other competitors. A better understanding of the company and what areas their competitors have put their focus towards aided the creation of the questionnaires and interviews for the pre-study, allowing for better definition of questions that line up with Volvo's target.

3.2.1 SWOT Analysis

The SWOT analysis helped identify what makes Volvo Trucks hold such a strong competitive position in the European market, being a frontrunner in electrification, technological leadership and its focus on driver safety and well-being. The main strengths of the company can be attributed to its technological focus and human-centered design philosophy. It is the market leader in Europe for heavy trucks (16 tons) and above, and had a reported market share of close to 19% in 2025 (Volvo Trucks, 2026). In addition, Volvo Trucks has established itself as a market leader in heavy electric trucks in both Europe and North America (Volvo Trucks, 2025). Another key strength identified in the SWOT analysis is Volvo Trucks' long-standing focus on safety and driver well-being, as showcased by their Vision Zero ambition which aims for zero accidents involving Volvo Vehicles (Volvo Trucks, 2026). Volvo Trucks has also put a strong focus on aftermarket services and connected vehicle solutions that contribute to higher uptime and reduce the operational stress put on drivers (Volvo Trucks, n.d., Volvo Trucks, 2024). Additionally, an internal study on driver comfort performed by Volvo Trucks shows that well-being improvements related to comfort, improved use of cab space, resting comfort and safety are top priorities for international long-haul drivers (Maury, 2023).

Weaknesses that affect Volvo Trucks were also identified. One of the biggest weaknesses that Volvo currently has is the weaker demand in North America due to broader market slowdowns in the freight section because of tariffs (Reuters, 2025). Another factor that acts as weakness to the brand is their premium positioning, emphasis on implementation of advanced technology, and features that contribute to higher vehicle costs. The transition to electrification also presents severe challenges for the company as it requires significant investment in new technologies and production systems. Despite being a company with such a high focus on sustainable solutions and the shift to electric vehicles, they are still a manufacturer of heavy vehicles, which have a negative impact on the environment.

Several opportunities for Volvo Trucks were identified in the SWOT analysis, with growth opportunities in regions outside of Europe being one of the key goals to fulfill. Urbanization and the development of smart cities give Volvo an opportunity to further differentiate itself through ergonomic design, improved visibility, reduced noise and advanced driver assistance systems. Related to this, their investments and engagement in electrification and alternative fuel solutions that are less polluting than traditional fuels also help increase the brand image. Another long-term opportunity is the implementation of autonomous and connected fleet solutions that would decrease driver workload, improve safety and mitigate the effects of driver shortages from an aging population of truck drivers (Cedefop, 2023).

Finally, threats that directly impact Volvo Trucks have also been identified. Economic instability directly affects the demand for freight and fleet investments, marking the truck market highly cyclical, as showcased by the company's recent decline in the North American market caused by the tariffs and weakened economy (Reuters, 2025). Another threat is rapid technological development which can increase the risk of disruption in sales, particularly as their competitors and new manufacturers heavily invest in electrification and automation. With the implementation of new technology and smarter vehicles there is also an increased cybersecurity risk that needs to be considered. Rising prices for manufacturing, energy and raw materials also directly impact the cost stability and margins the company is trying to reach.

3.2.2 PEST-EL Analysis

The PEST-EL analysis was performed as a complement to the SWOT analysis, examining external risks and opportunities that affect Volvo Trucks and their operating environment. Looking at Volvo Trucks from a political perspective, they are increasingly affected by trade relations between different regions and the geo-political state of countries in these regions. Additionally, public infrastructure investments that prioritize safety, sustainability and quality of life are things Volvo needs to consider when designing trucks. Low-emission zones and safer traffic in urban areas increase demand for vehicles that are designed with environmental performance and pedestrian well-being in mind (Porter's five forces). Political support for industrial investments such as approval to build a battery factory in Mariestad, (Swedish Courts, 2026), strengthens Volvo Trucks' ability to develop electric vehicles, securing themselves from geo-political instabilities by not having to rely on manufacturers in other countries.

Freight demand, which is closely tied to economic growth, is an economic factor with a strong influence on the heavy truck market. Economic slowdowns or instability can delay investments in fleets (sales of new trucks) and increase the price (Reuters, 2025). Economic pressure also heightens the importance of driver retention and operational efficiency, making investments in expensive vehicles with a high number of customers that appreciate them much more attractive to fleet operators. According to McKinsey & Co. (2024), the European market is set to go from 200000 truck driver jobs that are unfilled to 745000 by 2028, also showcasing a clear difference in the age of workers with ages 55+, being the majority share at 33%. With the lack of professional drivers in the future, the costs to operate will increase, emphasizing the need for autonomous trucking to keep on operating at the required level.

Social factors are relevant to the company and specifically relevant in this case to the focus on driver well-being, which is investigated during this thesis work. Improving driver comfort, safety and in-cab working conditions has therefore become a necessity rather than a differentiator (Cedefop, 2023). Urbanization projects further amplify these trends as drivers are required to operate in complex urban environments where good visibility and maneuverability is critical. In addition, Volvo's zero-vision acts as a statement from the company to the public, showcasing that they are serious about achieving a zero-accident future. With electrification initiatives, changes will be made to existing truck stops to account for more electric vehicles, trucks included. This change will lead to truck drivers staying for longer periods of time due to the limitations of the electrical grid. According to Power Circle AB

(2023), “One way to size charging stations at public truck stops is based on the need for overnight charging, so that the available power can be used for fast charging at fewer stations during the day”. This compromise between nighttime truck charging and fast charging for vehicles during day time could potentially lead to more drivers staying for longer periods of time, giving them more time to prepare food or eat at nearby restaurants.

Technological factors such as electrification not only help the environment, but also reduce the noise, vibration and local emissions, directly improving the surrounding environment for pedestrians and drivers operating the trucks. Advances in advanced driver assistance systems and semi-autonomous functions aid in reducing the cognitive and physical workload, which enhances safety and comfort (Volvo Trucks, 2025). While Volvo are focusing on the transition to electric transport for their trucks, they are also developing hydrogen and other alternative fuels for long-haul applications, however battery electric vehicles (BEV’s) currently offer the most immediate benefits. Outside of Volvo’s own technological factors, the electrification initiative has an impact on truck drivers in several ways such as needing to plan routes by taking weather and climate’s impact on battery range into consideration (Törneholm, 2023).

Legal factors heavily impact Volvo Trucks, especially those relating to stricter safety, integration of driver focused technologies, and emissions regulations like the upcoming Euro VII regulation (Council of the European Union, 2024). Keeping this in mind, compliance with data privacy regulations such as GDPR when handling driver data and cybersecurity regulations like UNECE R155/156 is becoming increasingly important as vehicles become more connected and automated.

One of the biggest factors that play a role in shaping Volvo Trucks’ strategy is the environment. Setting targets for CO2 reduction and net-zero emission ambitions aid in accelerating the shift toward electrification which improves air quality and reduces the levels of pollution caused by trucks. Increasing the focus on circular designs and proper lifecycle management further plays an important role in designing vehicles, going so far as to affect the ergonomics and interior material choices of the cabins (Volvo Group, 2026).

3.2 Market Analysis

A market analysis was performed to showcase Volvo Trucks' performance compared to its main competitors. The analysis shows that Volvo Trucks’s strong performance is closely linked to their ability to combine technological leadership with a clear focus on driver well-being. Volvo Trucks was the market leader in Europe for heavy trucks in 2025, strengthening its market position compared to previous years (Volvo Trucks, 2026). Additionally, they have also claimed a leading position in the North American market in the segment of heavy electric trucks, with a market share surpassing 40% in 2024 (Volvo Trucks, 2025).
Volvo Trucks’ largest offering, the Volvo FH16 Aero XXL represents their commitment to driver well-being through the lengthened cab which hosts a sleeping area designed for comfort, functioning as a habitable space more reminiscent of a bedroom than the interior of a truck (TheTruckCompany, 2025a). Despite this, the layout remains largely unchanged when compared to the rest of the line-up and the market competition. It features the same size refrigerator, storage modules, 24-Volt microwave, and limited roominess due to the extension of the bed. This in turn means that although the cab is longer, there is a lot of dead space that can be reconfigured to allow for a better resting comfort experience.

Looking at the European market, there is high competition between heavy truck manufacturers with some of Volvo's biggest competitors being Scania, Mercedes-Benz, DAF, and IVECO (ICCT, 2025). What sets Volvo Trucks apart from the competition is however a particularly strong focus on safety, driver-centric design, and technological investments. One of their biggest competitors, Scania, is highly established and has highlighted efficiency and powertrain performance. Despite this, they have experienced declining deliveries due to recent market fluctuations (Scania, 2025), whereas Volvo has seen a rise in deliveries. While competitors also invest in comfort and improving their driver's well-being, Volvo's interior noise performance (for the FM model) was noted as the best in an older test performed by EuroTransport (2015), further cementing their long-standing focus on improving driver well-being.

Scania's S-series Highline has a distinct flat floor, offering a wide range of customization options, and features that remind them of a luxury car compared to other truck brands (TheTruckCompany, 2025b). Their passenger-side table which folds out from the dashboard allows the drivers to detach themselves from the driving aspect by offering an ergonomic solution for eating which is currently not found in any of Volvo's offerings, see Figure 9.

Figure 9. Scania S-series passenger side table, TheTruckCompany (2025b)

The DAF XG+ takes a new approach to improving the resting comfort aspect of their truck through an innovative lounge configuration. By taking full advantage of the updated EU cab-length regulations, DAF has engineered a significantly elongated cab similar to Volvo's largest offering. This design choice reflects a broader recognition for improving the living space inside the cab with their innovative layout which allows the driver and passenger to easily use a table which pulls out from the middle of the dashboard. The larger cab allows the chairs to swivel around in ways that would otherwise not be possible, while simultaneously giving drivers an increased sense of roominess by keeping the bed size standard (TheTruckCompany, 2025c). See Figure 10.

Figure 10. DAF XG+ cab interior, TheTruckCompany (2025c)

Mercedes Benz also approaches the living space problem through an innovative layout in a concept called the Mercedes-Benz Solostar, see figure 11. Featured as part of the Actros L GigaSpace, the model features an innovative interior layout which can be likened to a studio apartment on wheels rather than a truck cab (TheTruckCompany, 2025d). Outside of reimagining the cab interior layout, it puts a large focus on digital integration and has been designed with extended-stay drivers in mind.


Figure 11. Mercedes-Benz solostar concept, TheTruckCompany (2025d)

Through a different approach, the IVECO S-way has changed from a fleet-utility oriented truck to what can now be described as a premium competitor in driver comfort and technology. The cab offers a more traditional interior similar to Volvo’s with a specific emphasis on wellness features and spacious interior more suited toward long-haul drivers (TheTruckCompany, 2025e)

Current industry trends related to automation and development of user-centric trucks further emphasize the need for wider implementation of zero-emission heavy trucks. While they still only represent a small share of total truck registrations, the number is increasing steadily, which is in part driven by regulatory pressure and urban policy demands to reduce noise and emission-related pollution (ICCT, 2025). As more electrified vehicles are deployed in urban and regional areas, the driver's comfort and well-being, ease of use, and safety become critical success factors. Additionally, a direct result of this trend is the decrease of importance of the driver. Summarized, the current competitive landscape reveals that every major European long-haul manufacturer is improving their cab layouts for the sake of improving driver well-being with their own unique approaches. Despite the general space and living comfort improvements, not much has been done about food-related support features. With the advancement of fully and semi-automated trucks there is an opportunity to make drastic changes to the cabin's interior layout. With current food-related offerings of most brands on the market consisting of low-powered microwaves, water kettles and refrigerators, there is a real possibility of integrating higher powered appliances with the shift towards fully electric trucks without make-shift solutions by drivers. As the cabin design has been relatively stagnant throughout the years there is an opportunity to fill a gap in the market by allowing for better food preparation and handling practices through integrated appliances or features. If the cabin develops into a living and working space rather than being mainly driver-focused like today, manufacturers that proactively develop these features will be much better positioned in the market to meet these needs.

3.3 Benchmarking

A benchmarking study has been performed through a Competitor Vehicle Analysis where six truck models have been analyzed and compared. These consisted of the available segment competitors to Volvo's FH16 Aero truck, focusing on competitor trucks with cabins of similar sizes. Key features such as storage capacity above and behind the drivers were compared, along with dimensions of retractable storage box and fridge under the bed. Different truck brands also offer different configurations, with some of the benchmarked trucks having an additional bunk bed, sacrificing storage capacity, and leading to a more cramped truck cabin.

Based on the findings of the CVA, the layout of the available trucks did not change in any major way. They all feature the same base configuration with a driver and passenger seat in parallel, along with a bed right behind them. Additionally, every model featured retractable units placed under the bed which houses an integrated fridge and additional storage. Extension and dimensions of the fridge and the accompanying storage unit were noted, showcasing similar sizes across all vehicles but with differences in sectioning or integration of other appliances. The models featured in the benchmarking analysis also vary in levels of equipment, which can explain the lack of certain food-related features like microwaves or coffee brewers/water kettles.

Interesting features were nonetheless identified in different trucks, such as the fridge in the IVECO truck which featured a separate hole which allowed easy access to a section which is suitable for water or soda bottles. Another thing to note about the IVECO S-way truck, which is consistent with the MAN TGX truck, is that the available storage containers above the driver seat were very angled, limiting the possibility of installing a microwave or similar appliances in them. The Mercedes-Benz truck cabin also featured very limited storage above the driver as they were lower than most of the competitor trucks but also featured integrated shelves which further limited the available height of objects that fit to around 100mm per shelf unit. The Hyundai Xcient truck features a similar storage configuration above the drivers but lacks a bunk bed like the three previously mentioned models. As such, it instead offers storage capacity above the normal bed which could allow for a microwave or similar appliances to fit.

The MAN GTX, Scania S770 G38 and Volvo FH16 Aero XXL stood out during the analysis as they featured additional storage which could be accessed through lifting the bottom bed. While the MAN truck featured a bunk bed it made up for the lost storage space by having additional storage availability below the lower bed. The Scania and Volvo trucks also featured a similar storage configuration below their respective beds but did not include an additional bunk bed, but rather a set of storage containers with generous storing capacity which is larger than the storage above the driver. Scania and Volvo were also the only trucks with integrated food-related features included in the cabin. They were also the most premium feeling, with the best utilization of the limited cabin space in a way that highlighted the resting comfort capabilities in the cab.

The Volvo FH16 Aero XXL specifically had the best mixture of storage, space availability and feature integration. It is important to note that the cabin is slightly larger than the other trucks in the analysis, allowing it to house a larger reclining bed which can be controlled through electric motors to allow for a more upright position while resting. A comprehensive analysis of the different truck models can be found in Figure 12. Additional photographs of relevant features deemed interesting are displayed in Appendix A.

	Hyundai Xcient 64T			IVECO S-way 42T			Mercedes-Benz Actros 1848 42T		
Dimensions (mm)	*Width*	*Depth*	*Height*	*Width*	*Depth*	*Height*	*Width*	*Depth*	*Height*
Dimensions fridge	330	380	320	380	370	290 to 310	220	410	340
Additional storage under bed	No			No			No		
Dimensions storage drawer beside fridge	230	550	320	350	550	360	260	660	380
Storage above driver	3 Storage Containers			3 Storage Containers			3 Storage Containers		
Dimensions top-side storage	700	200	300	800	340	630	690	350	290
Dimensions top-middle storage	700	200	300	800	170	630	690	350	290
Room for Microwave	No			No			Yes		
Room for coffee brewer	No			No			Yes		
Storage behind driver	3 Storage Containers			No, bunk bed			No, bunk bed		
Dimensions top-side storage	570	380	460	-	-	-	-	-	-
Dimensions top-middle storage	690	380	460	-	-	-	-	-	-
Room for Microwave	Yes			No			No		
Room for coffee brewer	Yes			No			No		
Dimensions between seats	900	570	-	970	510	-	970	580	-
Dimensions between open fridge and front area	-	150	-	-	150	-	-	220	-
Storage around bed	Small shelves/nooks			Small shelves/nooks			Small shelves/nooks		
Additional notes	Very angled storage containers			Drink holder in fridge with easy access			Limited space between bed and seats		
	Low-end model			Very angled storage containers			Very low storage containers with shelves		

Dimensions (mm)	MAN TGX 18.480 42T			Scania S770 G38 62T			VOLVO FH16 AERO XXL 62T		
Dimensions fridge	*Width*	*Depth*	*Height*	*Width*	*Depth*	*Height*	*Width*	*Depth*	*Height*
Additional storage under bed	300	540	300	200	600	300	340	360	300
Dimensions storage drawer beside fridge	Yes			Yes			Yes		
Storage above driver				320	700	360	340	280	300
Dimensions top-side storage	3 Storage Containers			3 Storage Containers			3 Storage Containers		
Dimensions top-middle storage	700	360	320	520	350	350	700	360	320
Room for Microwave	770	430	230	660	350	320	770	430	230
Room for coffee brewer	No			Yes, included			Yes, included		
Storage behind driver	No			Yes, included			Yes, included		
Dimensions top-side storage	No, bunk bed			3 Storage Containers			3 Storage Containers		
Dimensions top-middle storage	-	-	-	600	300	540	520	420	420
Room for Microwave	-	-	-	600	300	540	840	380	420
Room for coffee brewer	No			Yes, included			Yes, included		
Dimensions between seats	No			Yes, included			Yes, included		
Dimensions between open fridge and front area	970	630	-	870	500	-	750	630	-
Storage around bed	-	150	-	-	60	-	-	50	-
Additional notes	Small shelves/nooks			Small shelves/nooks			Small shelves/nooks		
	Great extra storage under bed (~50L)			Great extra storage under bed (~50L)			Great extra storage under bed (~50L)		
	Limited space between bed and seats			Integrated Microwave and coffee brewer			Integrated Microwave and coffee brewer		
				Limited space between bed and seats			Extra wide bed		
							Flat dashboard		
							Movable fridge sectioning		

Figure 12. Competitor Vehicle Analysis

As the vehicles that were benchmarked are competitor trucks, not all of them are fully equipped with the available accessories offered by the manufacturers. An additional benchmark study of available in-cab food-related features has therefore been conducted, highlighting the differences in accessories available depending on the brand, giving a rough idea about their user's needs. The accessory benchmark study was based on product catalogs available for each of the previously analyzed truck brands to get an accurate representation of their product offering. Based on the accessory benchmark, the three brands that offered the largest selection in accessories related to resting comfort and food preparation were MAN, Scania and Volvo. However, the accessory selection across these three brands is mostly the same with some small variations in execution or applicability to specific truck models. For the full accessory benchmark, see Figure 13.

	Hyundai	IVECO	Mercedes-Benz	MAN	Scania	Volvo
Dashboard Table	 Integrated table			 Dash storage board	 Foldable table	
Microwave		 Full-sized microwave	 Full-sized microwave	 Small low-powered microwave	 Small low-powered microwave	 Small low-powered microwave
Coffee Machine/Water Kettle			 Coffee machine with pods	 Two available versions	 Water kettle also available	 Mounted under bunk
Garbage Can				 Between seats	 Between seats	 Between seats
Water tank for exterior storage		 10L tank with soap dispenser				 6.5L tank
Other		 Portable fridge (15L / 21L)	 Double fridge configuration		 Extra large fridge/freezer	 Bunk rail table

Figure 13. Accessory Benchmark. Images reproduced from accessory catalogs (Hyundai motor company, n.d.; Scania, n.d.; Volvo Truck, n.d.; Mercedes-Benz Trucks, n.d.; IVECO, n.d.; MAN Truck & Bus, n.d.)

3.4 Patent search

The patent search was performed in two stages, first by using key word search to see available patents based on relevant keywords related to truck cabins. However, as the number of patents that were displayed surpassed several thousand, an alternative approach using CPC classification search was followed. The main classification followed in the patent search was *CPC B62D33/0612 Superstructures for load-carrying vehicles*, which included cabins with living accommodation and related features for long distance road vehicles. From the classification search, the number of patents was reduced to 575, which were subsequently analyzed to find innovative solutions and prevent future infringement. During the patent search, the patent validity period of 20 years from the filing data was considered to prevent infringement on existing patents that are still under protection. The analysis concluded with nine patents that displayed interesting properties and features, with a mix of features that have already been identified in available trucks through benchmarking and completely new ones that utilize the truck cabin's space in innovative ways. The patent search aided in expanding the understanding of conceptual cab layouts as well as aided in the later idea generation stage through providing inspiration.

3.4.1 Modular Truck Assembly

The invention that has been patented is a modular truck sleeper assembly which allows truck cabins of various sizes and trim levels to be built on the same assembly line through the pre-assembly of the cabin floor and sides. The patent was originally applied for in 2001 by Moriaux in the United States as US2002096913A1 and was later published in 2002. Additionally, Mack Trucks also applied for the patent with Roland as an inventor through Canada's patent office under CA2368317A1. The interesting part of the patent is not the assembly method but rather the illustrations depicting modular resting comfort solutions which have different elements that are incorporated in existing truck cabins. The patent represents a conceptual approach to modular cabin interiors rather than widely implemented solutions, making the risk of infringement of the patent low. See Figure 14.

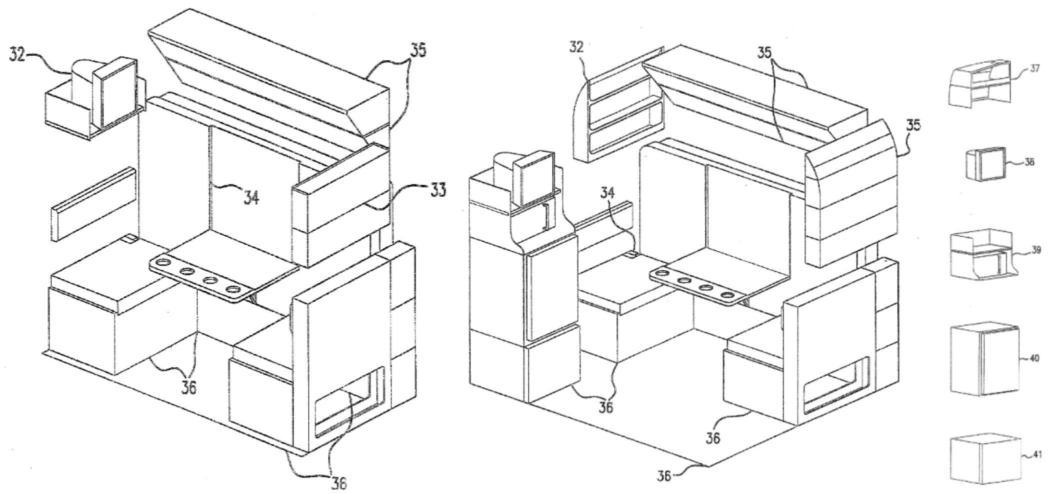


Figure 14. Conceptual interior illustrations of patent US2002096913A1

3.4.2 Module Carrier for Driver's Cabin

The patent describes a modular carrier (storage) system intended for installation in truck cabins. The carrier system consists of a base with a back support arranged perpendicular to one another, equipped with fixing means that allow the modular system to be attached to the corresponding mounting points inside the cabin. The illustrations presented in the patent focus on the structural layout of the modular storage system, see Figure 14. The figures show a frame-based construction designed to support interior elements such as storage, bedding, and seating through different modular configurations that are relevant for resting comfort in cabins. Patent DE102005020613A1 illustrates an incremental approach to a modular system where things can be added depending on the need or context. The solution does not propose novel space layouts as it is meant to be mounted where the existing beds are, offering very limited real functional value when compared to trucks from the Competitor Vehicle Analysis performed in chapter 3.1.3 Benchmarking due to collision with the seats. The inventors of the patent are Angenendt, Wagener, Luepfert. The patent application was sent in by Isringhausen GmbH & Co. KG in 2005 and was published in 2006 in Germany.

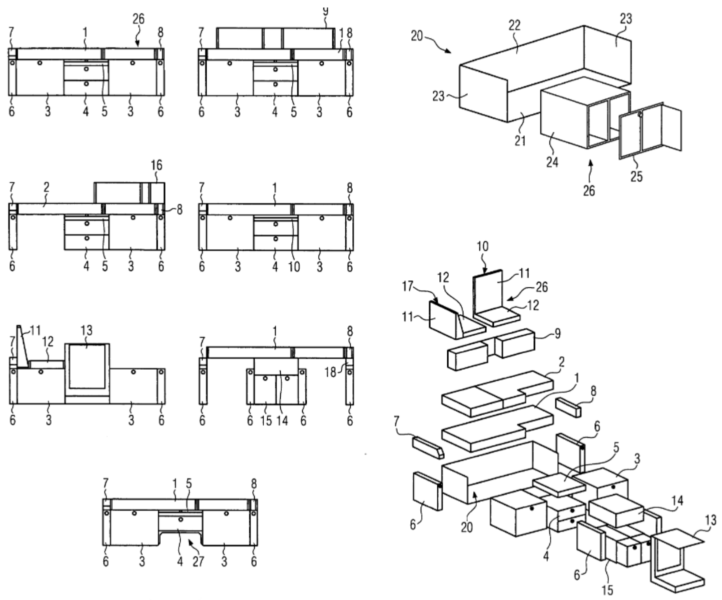


Figure 14. Modular storage system

3.4.3 Folding table arrangement for use in driver cabin of motor vehicle

Patent DE102008027791A1 was applied for by Daimler AG, owners of Mercedes-Benz in 2008 and published in 2009. Inventors Hentsch et al. Created a folding table arrangement situated under the bed located at the back of the cabin. It works similarly to how the fridge and storage boxes are pulled out that currently reside under most truck beds as showcased by the CVA. Based on illustrations of the patent, the table is designed to be pulled out from under the bed and extendable in different manners, see Figure 15. From a functional perspective the patent illustrates a practical and well-integrated solution for introducing extra space to place food or other items in the limited cabin interior. Similar solutions to the folding table have not been identified in the CVA, leading truck drivers to utilize whatever space is available, like the steering wheel in its most upright position, or by folding down the passenger seat.

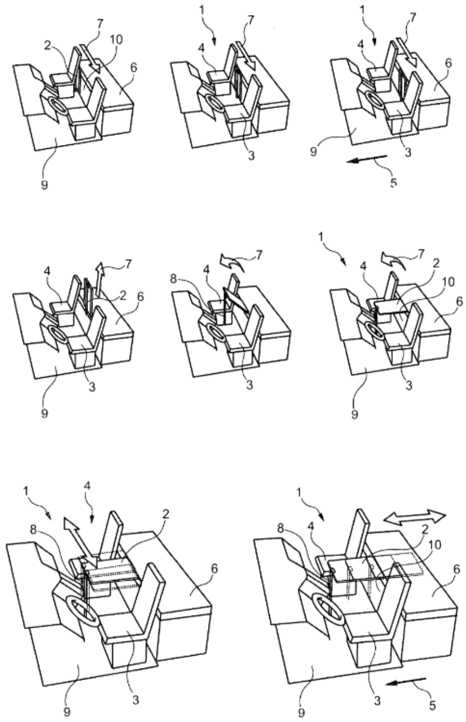


Figure 15. Folding table arrangement

3.4.4 Modular bed adapted to be composed of a plurality of modular elements

EP1598261A2 describes a modular bed system intended for use in truck cabins, where the bed is composed of a plurality of modular elements that can be arranged in different configurations. The patent was applied for in 2004 by OMG srl and published in 2005, with Migliorin and Boggio listed as inventors. The patented solution is composed of a modular bed containing several different configurations and mainly consists of a mattress divided into three movable parts. These movable parts are adaptable and can be configured with the equipped accessories as depicted in the illustrations, see Figure 16. The interesting part of the patent is the modular design approach rather than the utilization of the bed itself, as it does not significantly interact with the surrounding cabin functions related to resting comfort. When compared to vehicles from the CVA, modular bed concepts are not available in any of the trucks that have been investigated.

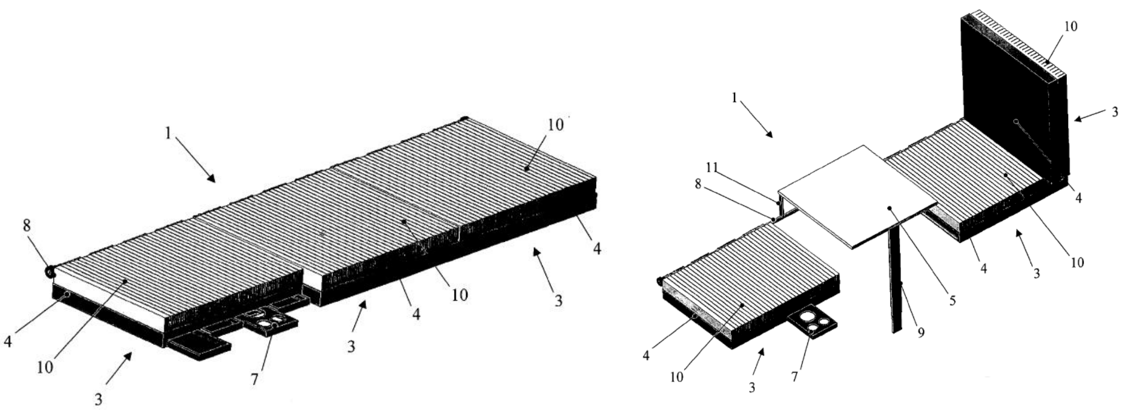


Figure 16. Modular bed with modular elements

3.4.5 Truck cabin with interior door

Patent EP1798137A2 showcases a completely novel approach to the truck cabin layout, featuring a separate room with functional devices that are arranged behind an interior door. Grammer AG applied for the patent in 2006 through the European Patent Convention together with the inventors Tomforde and Moreno. The patented innovation focuses on the introduction of a physical divide between the driving area and the rear cabin area, creating separate zones in the limited space through structures rather than curtains as is most common, based on findings from the CVA. From a functional perspective, the solution is very novel and focuses on improving comfort for the driver during rest periods. However, there are some issues with the solution such as the introduction of a fixed interior door which occupies valuable cabin volume and reduces spatial openness. It also requires a very tall truck cabin interior to be implementable, with further issues related to storage and available space to pull down and enter the beds. The patent represents an interesting conceptual approach to functional zoning with potential uses such as a shower chamber or washroom being illustrated, see Figure 17.

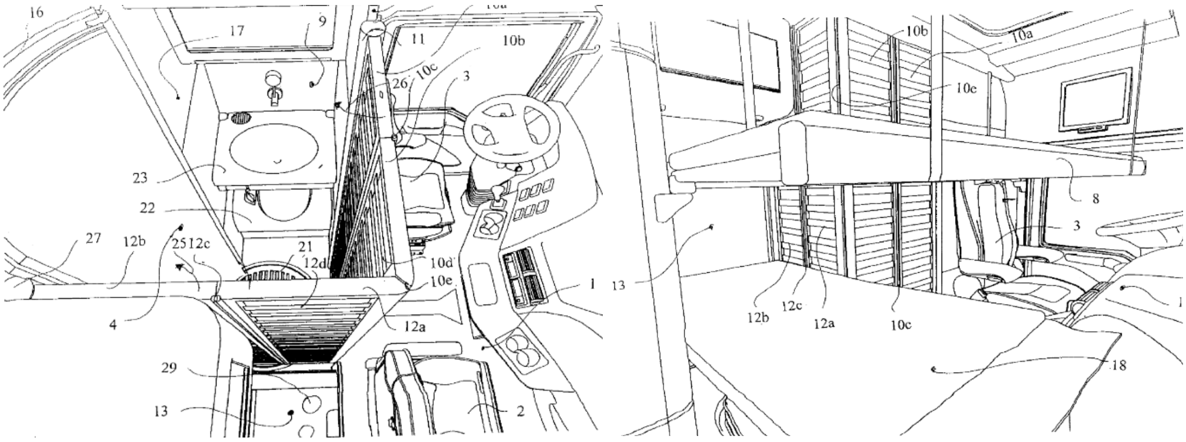


Figure 17. Innovative truck cabin layout with separate room

3.4.6 Truck head

CN114030531A describes a full truck cabin interior layout featuring an extendable bed system which allows two occupants to lie in an L-shaped configuration once the passenger seat has been rotated. The patent was filed 2021 in China and published in 2022 by Dongfeng Liuzhou Motor Co LTD, and created by inventors Tang et al, focusing on a maximized sleeping area with a small, separated room. The design emphasizes the maximization of resting comfort areas in the cabin interior, optimizing the cabin space by utilizing the existing passenger seat to allow for extension of the bed. The configuration is novel when compared to existing vehicles as showcased by the CVA, but an important note is the lack of illustrated storage available, see Figure 18. Most existing solutions on the market are comprised of fixed beds with little to no adaptability but come with a greater range of storage capacity. Overall, the patent showcases an inventive layout which aims to maximize the driver and potential passengers resting comfort, the solution provides a useful perspective on alternative utilization of space.

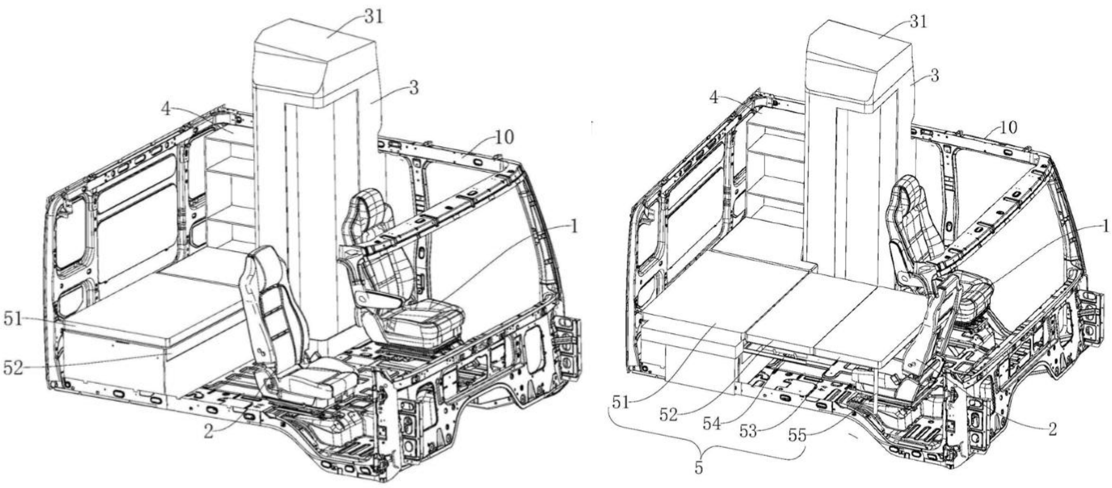


Figure 18. Truck Cabin Configuration

3.4.7 Folding Wash Basin in a Vehicle

Patent EP0318871A1 relates to a folding wash basin designed for use in a truck cabin. The patent was created by Hannig, M. and Cameron, I. in collaboration with Iveco Magirus in 1988, and published in 1989. The patented solution illustrates a wash basin which can be folded down from the underside of a table or bed, aiming to provide a compact hygiene solution that can easily be stowed away when not in use. The wash basin occupies minimal space in its stowed position, and when folded down it also offers a lid which can be used as a table surface or similar. When comparing with trucks from the CVA, the solution is completely novel despite its age, being more reminiscent of a solution found in the interior of an RV rather than long-haul truck. Although the patent addresses an aspect of living comfort that is relevant for long-haul drivers, the specific mechanical implementation comes with some issues. With that said, the solution does not take away as much space as many other patents that have been found and is much less invasive when looking at existing cabin layouts. Additional accessories like a stove and water containers for storing clean and dirty water are also illustrated in the patent, see Figure 19.

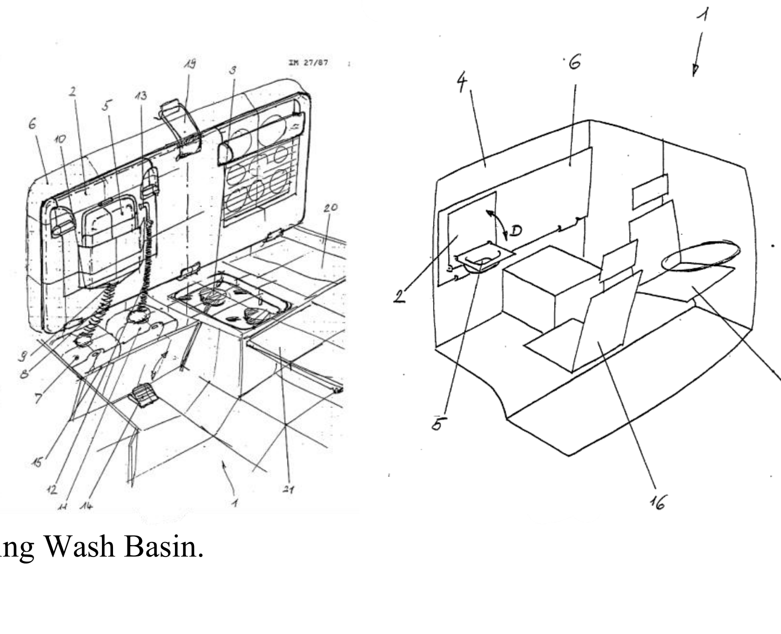


Figure 19. Folding Wash Basin.

3.4.8 Stove-sink combination in a driver's cab of a lorry

EP0190716A2 is a patent created by Kraus and Egle Elmar together with Iveco Magirus in 1986. It describes a combined stove and sink unit intended for installation within the truck cabin, mounted in the storage area underneath the bed. The solution focuses on the integration of basic cooking and washing facilities into the otherwise limited interior space of a truck cabin, see Figure 20. The illustrations depict a storage box which can be pulled out from under the bed, doubling as a food preparation area and small table together with the stove and sink. Functionally, the patent addresses an important need in resting comfort improvement for long-haul truck drivers, where available trucks lack proper food preparation appliances outside of low-powered microwaves. When compared to trucks from the CVA, manufacturers generally avoid fixed cooking solutions in favor of portable appliances or external facilities, prioritizing interior space efficiency and storage possibilities.

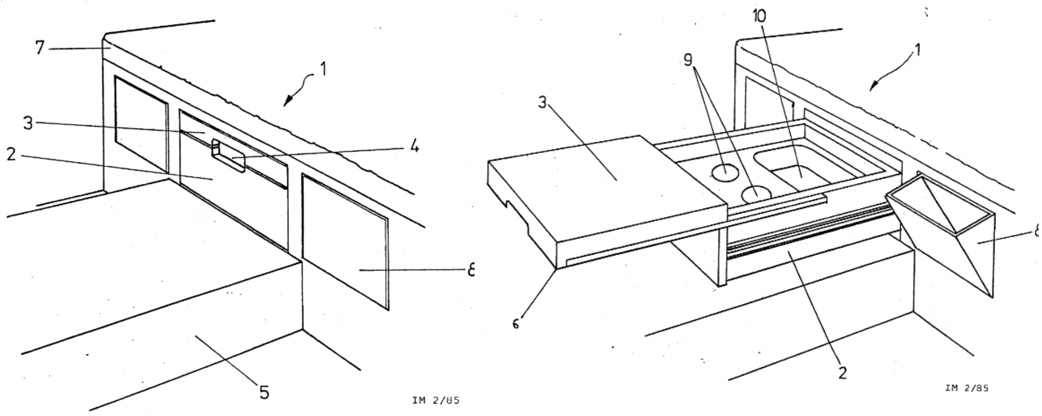


Figure 20. Integrated stove-sink combination in truck cabin

3.4.9 Single heavy truck living cabin based on L4-level automatic driving

In the patent, a concept for a single living heavy truck developed around L4-level automated driving is described, proposing a cabin interior layout that leverages autonomous driving to redefine how space is used within the truck. CN117125153A was filed in China by Proton Automotive Tech LTD in 2023 and created by innovators Song et al. The illustrations depict a cabin layout with a highly integrated living environment where the traditional passenger position has been removed in favor of resting and living functions, see Figure 21. The patent explores an innovative cabin design which is enabled by the high levels of automation, limiting the driver's required input. The solution features a separate bathroom integrated with the cabin interior, as well as a large bed with storage possibilities underneath. Comparing the patented solution with the available trucks from the CVA showcases clear differences, mainly because L4-level automation is not yet commercially available for long-haul trucking in Europe. The patent showcases a futuristic and novel interior design, representing a truck cabin of the future through a conceptual solution rather than one which is applicable to current vehicles. The patent does however provide valuable insight into how automation could influence the special layout and resting comfort of truck cabins.

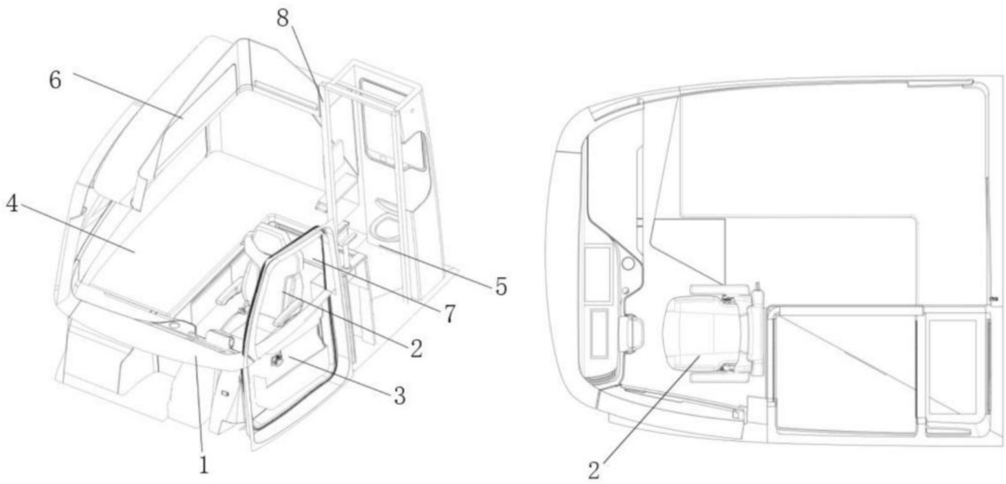


Figure 21. Single driver heavy truck based on L4-level automatic driving.

3.5 Legislations

Legislations that directly relate to the truck cabin interior and other relevant areas such as safety, driver well-being and data gathering have been identified and compiled. The regulations and laws that have been identified will be included in the requirement specification and serve as a guide to rely on throughout the concept generation phase. See table 3.

Table 3. Compilation of relevant legislations.

Title	Regulation	Institute	Area
Driving Time and Rest Periods	(EC) No 561/2006	European Commission	Resting
Regulation for mandatory rest breaks for truck drivers, creating a practical need for food preparation, storage facilities and overall resting comfort applications in the truck cabin (European Commission, 2006).			
General Data Protection Regulation	(EU) 2016/679	European Parliament and Council	Data collection
Relevant for the data collection part of the thesis work and in the case that the concept ends up including connected devices or apps that collect driver data related to well-being or eating habits (European Parliament and Council of the European Union, 2016).			
Reducing interference between electrical and electronic devices	(EU) 2014/30	European Parliament and Council	(Electrical)
The directive serves as a guide to ensure that equipment does not cause electromagnetic disturbance, which would be relevant for cooking appliances in the truck cabin (European Parliament and Council of the European Union, 2014a).			
Low Voltage Directive (LVD)	(EU) 2014/35	European Parliament and Council	Electrical
Ensures that any electrical appliance installed in the truck cabin meets safety requirements for low voltage equipment such as microwaves, induction stoves, water kettle/coffee machines and refrigerators (European Parliament and Council of the European Union, 2014b).			
General Safety Regulation	(EU) 2019/2144	European Parliament and Council	Design
The General Safety Regulation sets safety requirements on the design of the truck such as driver visibility, indirectly affecting the cabin's interior design (European Parliament and Council of the European Union, 2019).			
Protection of the occupants of the cab	(UN/ECE) Regulation 29	Economic Commission for Europe of the United Nations	Safety
The regulation requires the truck cabin structure to withstand frontal collisions while protecting occupants. Relevant for concept generation as accessories and appliances fit for food handling or			

resting comfort do not become a hazard in the event of a crash (United Nations Economic Commission for Europe, 2010).			
Burning behavior of materials used in the interior construction of certain categories of motor vehicles	(UN/ECE) Regulation 118	Economic Commission for Europe of the United Nations	Safety
Regulates the flammability of materials used in the truck's interior, directly relevant for materials used for the concept (United Nations Economic Commission for Europe, 2024).			

3.6 Survey

The survey consisted of 38 questions, covering areas from background information to how the profession affects the overall well-being of drivers. The survey study was not limited to long-haul drivers, but also included other types of professional truck drivers, such as those working in construction, mining and off-road driving, as well as drivers with local or regional routes. This broader sample allowed for a more comprehensive understanding of the well-being of the professional group as a whole.

Despite distribution via social media, the response rate was limited, and it took an average of about 17 minutes to complete the survey. To increase participation, the survey was also distributed via internal networks within Volvo Trucks with contact with drivers and haulage companies. This resulted in a slight increase in the number of responses, but at the same time meant that the sample became more geographically concentrated than initially intended. It was also noted that some questions were perceived as less relevant depending on the drivers' specific areas of work.

A total of 47 responses were collected. The age distribution was relatively balanced, though respondents in the 18–24 age group were in the minority, while those aged 55 and older constituted the largest share. A significant proportion of respondents (45%) reported having more than 21 years of professional experience. Regarding gender, 68% of respondents identified as men and 32% as women, which was a notable discrepancy compared to data from the United States, where female truck drivers accounted for only 3.2% of an inspected sample of 20 million drivers in 2019 (Scott & Davis-Sramek, 2023). Of all respondents, only 28% were identified as long-haul drivers, which represented the primary target group for this study. Regarding truck brands, Volvo was the most commonly used among respondents, followed by Scania. When it comes to working hours, the majority of respondents reported not working night shifts, and those who do were found to sleep at home rather than in their trucks.

Among the areas investigated eating habits emerged as the most prominent negative influencing factor, followed by sleep, stress and work-related conditions, see Figure 22. This was in line with previous research in the field.

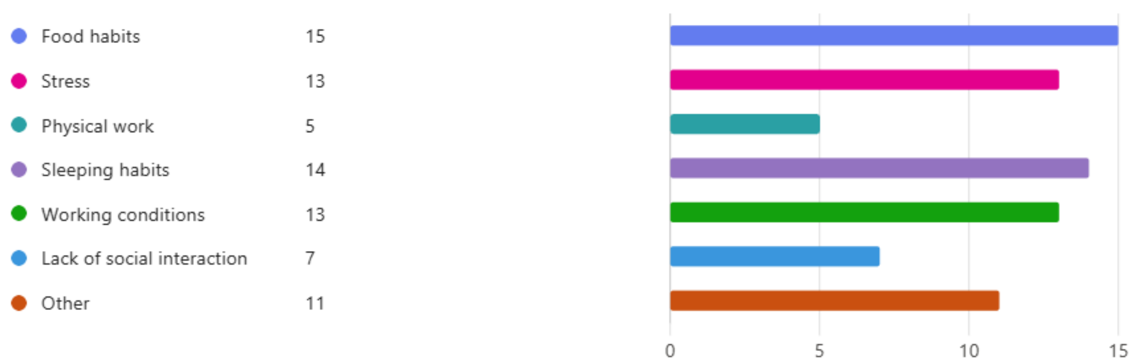


Figure 22. Results from the question "Out of the factors that have been investigated during the survey, which affect your well-being the most in a negative way?"

When asked to identify the aspects of their food and eating habits that were most negatively affected, the majority of respondents (n=26) noted their energy levels, of whom 8 were long-haul drivers. Long-haul drivers also reported a notably high rate of concerns regarding physical health, which constituted the second most frequently cited factor across all respondents, see Figure 23.

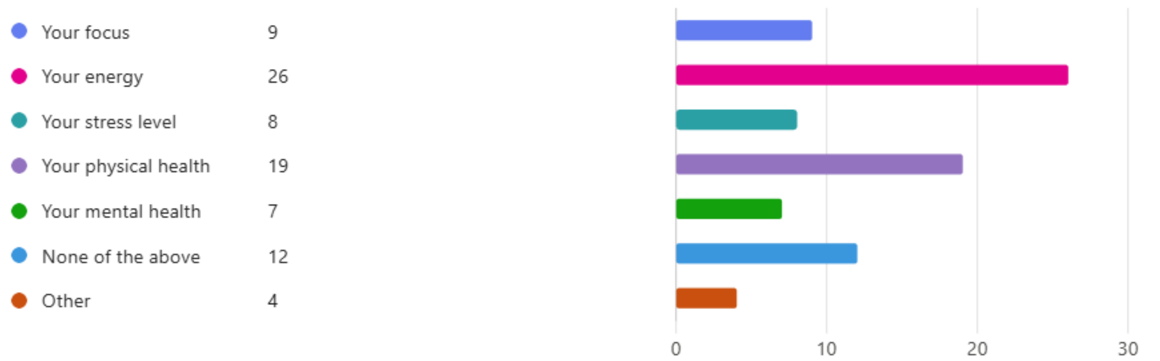


Figure 23. Results from the question "Which of the following options do you perceive to be negatively affected by your food and eating habits? (multiple choices)"

Despite these concerns, the vast majority of respondents (37 out of 47) reported bringing some form of home-cooked meals while working, and the majority (22 out of 47) purchased food during working hours less than once per week. Furthermore, respondents rated the food preparation facilities available in their cabs relatively highly: 32% of all respondents awarded a rating of 5 out of 5 (indicating very good) and this number was even higher among long-haul drivers, of whom 53% assigned the same rating. In table 4 below, the highlighted categories are shown with the corresponding total count and proportion of long-haul drivers.

Table 4. Highlighted categories from survey.

		Total sample (n=47)		Long-haul drivers (n=15)	
Category	**Subcategory**	**Count**	**%**	**Count**	**%**
Gender	Male	32	68%	12	80%
	Female	15	32%	3	20%
Age	18 – 24	5	11	2	13%
	25 – 34	8	17	3	20%
	35 – 44	11	23	2	13%
	45 – 54	9	19	4	27%
	55+	14	30	4	27%
Experience	<5 years	9	19	1	7%
	5 – 10 years	6	13	3	20%
	11 – 20 years	11	23	2	13%
	>21 years	21	45	9	60%
Night shifts per week	1 – 2 nights	9	19%	5	33%
	3 – 4 nights	2	4%	2	13%
	5+ nights	4	9%	2	13%
	Never	32	68%	6	40%
Nights spent at home per month	<7	5	11%	3	20%
	7 – 14	5	11%	4	27%
	14 – 21	7	15%	5	33%

	>21	4	9%	1	7%
	Always sleep at home	26	55%	2	13%
Truck brand	DAF	1	2%	0	0%
	Iveco	4	9%	0	0%
	MAN	2	4%	1	7%
	Scania	11	23%	1	7%
	Volvo	28	60%	13	86%
	Other	1	2%	0	0%
Ranking of food preparation features (1 = very bad, 5= very good)	1	4	8%	1	7%
	2	5	11%	0	0%
	3	7	15%	2	13%
	4	7	15%	3	20%
	5	15	32%	8	53%
	Do not exist	9	19%	1	7%
Negatively affecting well-being (multiple choice)	Food habits	15 *		6 *	
	Physical work	5 *		2 *	
	Sleeping habits	14 *		5 *	
	Stress	13 *		4 *	
	Working conditions	13 *		5 *	
	Lack of social interaction	7 *		2 *	
	Other	11		4	
Food habits negative effects (multiple choice)	Focus	9 *		4 *	
	Energy	26 *		8 *	
	Stress level	8 *		3 *	
	Physical health	19 *		7 *	
	Mental health	7 *		2 *	
	None of the above	12		5	

*Count reflects the proportion of respondents who selected each option on the multiple-choice question.

The rest of the survey results can be seen in appendix B.

3.7 Interviews

A total of ten semi-structured interviews were conducted with long-haul truck drivers digitally, including two face-to-face interviews carried out during a field study at Stigs Center, which is a popular truck stop in Gothenburg. The demographic split across the ten participants was seven males and three females. All participants drove either Volvo Trucks or Scania, reflecting the dominance of these two brands in the Swedish long-haul market. Experience among the drivers ranged from 4 to 25 years of long-haul driving, covering routes across Sweden, the Nordic countries, and continental Europe. The interviews were conducted online via video call and followed a structured yet flexible format. Each interview took between 30 to 60 minutes and was organised across five phases, starting with a brief introduction covering consent and GDPR compliance. The next consisted of a warm-up section with questions related to their profile, followed by general questions about their daily routines, food habits, and in-cab equipment. The fourth part was a phase focused on well-being and improvement ideas, finally concluded with a short wrap-up of the interview. A branching structure directed participants into one of three detailed question tracks depending on whether they primarily brought food from home, purchased food on the road, or cooked in or outside the cab. Follow-up probing questions were applied throughout the interviews to gain responses with more depth and to encourage detailed explanation about how certain elements are perceived or experienced in the eyes of the interviewee. The full interview template is available in appendix C.1.

A field study was performed at Stigs Center as a complementary data gathering opportunity. The field study consisted of a shorter interview format of nine questions based on the research questions and designed to minimise disruption to drivers on their breaks. Despite the accessible location, finding willing participants proved challenging and only two drivers agreed to be interviewed. While the number of interviewees during the field-study was small, their responses reinforced and extended the patterns identified in the longer interviews. The interview template used in the field study can be found in appendix C.2.

3.8 Summarized results of the Pre-Study

The pre-study provided a comprehensive foundation for the thesis work by establishing both the professional context of long-haul truck driving, existing market offerings, and the specific needs and pain points of long-haul drivers in Northern Europe.

The literature review gave an initial and necessary understanding of the long-haul profession and its consequences for driver health and well-being. It highlighted that the target group faces significantly elevated health risks compared to the general population, including cardiovascular disease, metabolic disorders, obesity, and depression, all closely linked to the structural conditions of the work. The literature review was instrumental in directing the project toward food-related well-being as the primary focus area and provided a theoretical foundation against which the independent findings from the thesis work could be interpreted.

The company and market analysis situated Volvo Trucks within the competitive European heavy truck landscape and confirmed its position as market leader with a strong focus on safety and driver-centric design.

The benchmarking study confirmed that the fundamental cab layout is largely consistent across all analysed vehicles. A notable finding was the included passenger-side tables present in the majority of the competitor's trucks which highlighted an ergonomic eating solution currently absent from Volvo's offering. The accessory benchmark further confirmed that available food-related items are largely identical across brands and mostly limited to the same set of portable appliances.

The patent search covered 575 patents and identified nine of direct relevance. The search provided useful perspective on both historically developed and futuristic solutions, many of which have not been commercially implemented. The most relevant patents to the project's scope were those addressing cab layouts, modular storage systems, and table integration adjacent to the bunk.

The legislation mapping identified the key regulatory requirements applicable in the European Market related to the cab interior. Additionally, external regulations which had a high impact on truck drivers and their habits were also included.

The survey collected 47 responses across a range of professional truck driver types, of which 28% were long-haul drivers representing the primary target group. The most significant finding was that eating habits emerged as the most prominent negative factor affecting driver well-being, ahead of sleep, stress, and working conditions. Despite this, drivers rated their current in-cab food preparation facilities highly and the majority reported bringing home-cooked meals to work. These findings together suggested that the problem is not primarily one of insufficient appliances or food access, but rather of the conditions and environment in which drivers eat.

A total of ten semi-structured interviews were conducted with long-haul truck drivers, including two face-to-face interviews carried out during a field study at Stigs Center in Gothenburg. The interviews uncovered daily routines, food habits, in-cab equipment, and well-being of the long-haul drivers. A complementary field study at Stigs Center was conducted using a shorter interview format, and while only two drivers agreed to participate, their responses reinforced and extended the patterns identified in the longer interviews.

4 Results of the Customer Needs Analysis

Customer needs have been derived through an extensive data analysis process based on the results of the pre-study. As part of the customer needs analysis, personas and a user journey map have been created based on interviewees. A customer needs list has been established through connecting the identified problem areas and needs from the data gathering step.

4.1 Interview analysis

To structure and interpret the qualitative data gathered from the interviews KJ-analysis, Gioia Coding and Thematic Coding were used as the main methods in identifying customer needs. This combined approach aligns with the customer needs identification methodology recommended by Ulrich and Eppinger (2012). Other areas that were explored during the interview analysis were identification of problems and barriers, solutions and requirements through thematic coding and supplemented by an Ishikawa Diagram Analysis. The key findings were then compiled and used to create

4.1.1 KJ-analysis

The KJ-analysis was performed by extracting statements from the interview transcripts and grouping them into thematic clusters based on shared meaning and user concern (Kawakita, 1982). The method involved writing each statement on a separate post-it note and iteratively grouping them by affinity until stable clusters labelled with a descriptive theme title emerged. Unlike the more narrow thematic coding, the KJ-analysis operates at the cluster level, revealing how individual statements fit into broader topic areas and highlighting which themes generated the most participant engagement across the sample (Scupin, 1997). This method proved particularly effective for transforming interview transcripts into actionable insights, ensuring that the resulting requirements were grounded in real driver experiences rather than assumptions which is consistent with the purpose of customer needs identification described by Ulrich and Eppinger (2012). The KJ Analysis is available in Appendix D.

4.1.2 Gioia Coding

A supplementary coding analysis using the Gioia Coding method was used after the KJ-analysis to easier interpret the interview data. Rather than only grouping together citations from the interviews as in the KJ-analysis, the Gioia method further contextualizes them through analysis at three different levels (Gioia et al., 2013). Four aggregate dimensions were identified. The first dimension, "Barriers to regular eating habits” encompasses themes relating to the absence of stable eating surfaces, underpowered appliances, insufficient refrigerator capacity, and hygiene routines managed through improvised workarounds. The second dimension, “Structural and scheduling barriers” relates to themes around the declining availability of suitable rest stops, the unpredictable schedules and their impacts on the drivers' food habits, and the economic pressure that makes home-prepared food a financial necessity rather than merely a preference. The third dimension, "Well-being as long-haul drivers" includes dietary habits, health awareness and physical activity. The fourth and final dimension "Cab as a social and living space beyond driving" groups themes around shared mealtimes, seasonal habits, and the desire to have a comfortable cab environment that feels like more than just a truck. The complete Gioia structure is presented in Figure 24 below.

Figure 24. Gioia Coding of KJ-analysis

4.1.3 Thematic Coding

The final step of the data analysis process was to use thematic coding to find themes from the interviews and previous analyses. The themes that were identified were then coded and divided into four areas related to life in the truck cabin:

- Identified problems and barriers
- Improvised solutions and workarounds
- Customer needs and wishes
- Functional requirements

This classification is particularly important in the context of cab design, where many comfort and usability needs are transformed into workarounds rather than voiced as explicit requests. This became more apparent as the number of interviews increased and the probing improved based on information gained from previous interviews.

The problems and barriers identified across all interviews were predominantly structural and scheduling-related rather than equipment-related, which contrasted with initial assumptions that food preparation hardware would be the primary source of frustration. The most universally shared problems were unpredictable schedules and parking shortages and appeared in all ten interviews and represent systemic challenges that extend beyond the cab itself.

Regarding food preparation, drivers were largely satisfied with their current in-cab setup. The primary complaint was that the microwave performs poorly when the engine is off. This requires drivers to idle the engine solely to achieve adequate heating speeds, a practice several participants identified as environmentally problematic. The standard 24V microwave was also criticized for its poor durability and high replacement cost, with multiple drivers reporting failures within a few years.

Eating surface ergonomics emerged as a concrete physical problem, with reach and comfort being the most prominent issues expressed by users. In several older Volvo models the dashboard slopes to improve driver visibility, this however has an impact on the user when sitting in the passenger seat and using the dashboard as an eating surface. In addition to having to lean forward to eat at the dashboard, the design caused lunchboxes to slide unless supported by bags or towels. Volvo models were specifically noted as lacking the fold-out passenger-side table present on Scania equivalents, and other competitor trucks as noted in the CVA in chapter 3.1.2. Refrigerator placement and capacity were also cited as being problematic as the fridge was mounted on the passenger side rather than next to the driver and becoming full very quickly by those who brought weekly meals from home.

One participant directly attributed a food-related illness to their dietary habits during an earlier long-haul career phase in Germany, where poor food access led to reliance on unhealthy options. While this was an isolated direct report, the underlying conditions of poor food access, long periods away from home, and reliance on roadside food were present to varying degrees in several other participants' descriptions. See table 5.

Table 5. Problems and barriers from the interviews

Problem / barrier	Priority	Interview frequency
Unpredictable schedule, meals skipped or delayed	High	10/10
Time pressure & stress as primary cause of missed meals	High	10/10
Parking & rest stop shortage	High	8/10

Dish handling — no practical washing solution in cab	Medium	7/10
Insufficient power supply at standstill for microwave	High	4/10
Refrigerator capacity insufficient for long trips or summer	High	4/10
Microwave durability, expensive and fails prematurely	Medium	3/10
No integrated rest stop planning tool	High	4/10
High cost of eating at roadside restaurants	Medium	4/10
Limited food variety during the week	Medium	3/10
Long-term health consequences from poor long-haul diet	High	1/10 (direct)
Doing dishes in-cab impractical, especially for cutting boards	High	2/10
Unstable or absent eating surface — dashboard slopes	High	2/10
Refrigerator placement too far from driver	Medium	1/10

Despite the barriers described in table 5, all participants had developed personal workarounds or strategies to manage their food needs on the road, see table 6. The most universal solution was to bring utensils, kitchen tools, spices and condiments, and preparing food at home with nine of ten participants bringing pre-bought or home-cooked meals for most or all working days. This approach was driven by a combination of cost savings, taste preference, health awareness, and not having to rely on roadside restaurants. Participants described planning their meals based on the number of days away and packing accordingly.

Water access was managed through personal water jugs, typically 10 liters, stored either inside the cab or in external storage lockers. Some participants carried several smaller bottles for different purposes such as drinking, handwashing, and brushing teeth.

For locating suitable rest stops and restaurants, drivers relied on Google searches, direct phone calls to petrol stations, and recommendations from colleagues rather than dedicated apps, which were perceived as unreliable. When asked about food delivery services, only one participant had experience with them but found them too problematic regardless.

Table 6. Solutions and workarounds from the interviews.

Solution / workaround	Prevalence	Interview frequency
Equipped cab “kitchen” (knives, boards, spices, utensils)	Medium	10/10
Food brought from home	High	9/10
Water jugs	Medium	7/10
Information gathering (Google, calling ahead, colleagues)	Medium	4/10
Improvised eating surfaces using towels or bags to stabilize food	Low	2/10
Using the trailer bed as a natural freezer in winter	Low	1/10

Customer needs and wishes were derived from both explicit statements and latent signals in the interviews, see table 7. The most universal latent need was for simplicity where every participant described prioritizing ease of use, minimal setup time, and avoiding anything that would complicate their daily routine. When probed or asked about the possibility of being able to cook in the cab, the majority of the interviewees were not interested, citing several reasons such as odor, complexity, and stress. This finding acts as a constraint on all other potential in-cab features any solution that adds complexity is likely to be rejected regardless of its functional benefit.

A stable, flat eating surface on the passenger side was the most common explicit need related to physical cab design, appearing in seven of ten interviews. Improved water access for hygiene rather than cooking was raised by eight participants, with strong consensus that this should be positioned outside or near the cab entrance rather than integrated into the resting or driving area.

Larger refrigerator capacity was raised by six participants, particularly those on longer routes or who supplement their weekly lunchboxes with fresh produce and grill food in summer. Better power supply at standstill was requested by four participants, with one explicitly framing this as an environmental issue as running the engine solely to heat food leads to unnecessary fuel consumption.

A notable latent need around dietary variety emerged from three participants who described meal-prepping the same dish for the entire week out of necessity rather than preference. This signals an unmet need for solutions that support meal variety without adding food preparation complexity. Outdoor cooking and social eating emerged as an underappreciated but recurring theme across four participants who either already owned a gas grill or expressed a desire for one, suggesting that food-related well-being is not confined to the cab interior.

Table 7. Customer needs and wishes from the interviews.

Need / wish	Type	Priority	Interview frequency
Simple and fast food handling, minimal setup time	Latent	High	10/10
Water solution for hygiene, running or easy-access water	Latent	High	8/10
Permanent integrated seating group, chair and table under bunk (lounge solution)	Explicit	High	7/10
Flat eating surface / table on passenger side	Explicit	High	7/10
Larger or additional refrigerator capacity	Explicit	High	6/10
Sufficient power supply at standstill	Explicit	High	4/10
Compact equipment (solutions that do not sacrifice storage space)	Latent	High	4/10
Better dish-washing solution	Explicit	High	4/10
Separate driving space from living space	Explicit	Medium	3/10
Dietary variety as a well-being factor	Latent	Medium	3/10
Integrated rest stop planning tool in infotainment system	Explicit	Medium	2/10

Sparkling water solution, would replace soft drinks and energy drinks	Explicit	Low	1/10
Grill in the summer	Explicit	Medium	4/10

Additionally, baseline functional requirements were identified and stated as non-negotiables, consisting of features or capabilities that every participant expected to be present and functioning in a long-haul cab. Ulrich and Eppinger (2012) describe this category as needs that are "obviously important" and form the baseline against which any concept must be evaluated before more differentiated features are considered. Their frequency in the interviews (10/10 for all six requirements) confirms that they represent the mandatory baseline for any viable concept. The six requirements are listed in table 8.

Table 8. Requirements identified from the interviews.

Requirements	**Priority**	**Interview frequency**
Refrigerator/freezer (fundamental cold storage)	High	10/10
Microwave oven (primary food heating tool)	High	10/10
Waste management (place to collect and store waste during the week)	High	10/10
Hygiene & cleanliness (easy-to-clean surfaces and storage for cleaning supplies)	High	10/10
Secure storage during driving (items stay in place under vibration and braking)	High	10/10
Utensil & lunchbox storage (secure and easy to access from both sides of the cabin interior)	Medium	10/10

4.1.4 Ishikawa Diagram Analysis

The Ishikawa diagram analysis identified the various causes and their contributing factors related to the effect of enhancing truck driver well-being through in-cab food-related features. Eight thematic branches were identified from the interviews and the following customer needs analysis, each representing a distinct category of causes and sub-causes. See Figure 25.

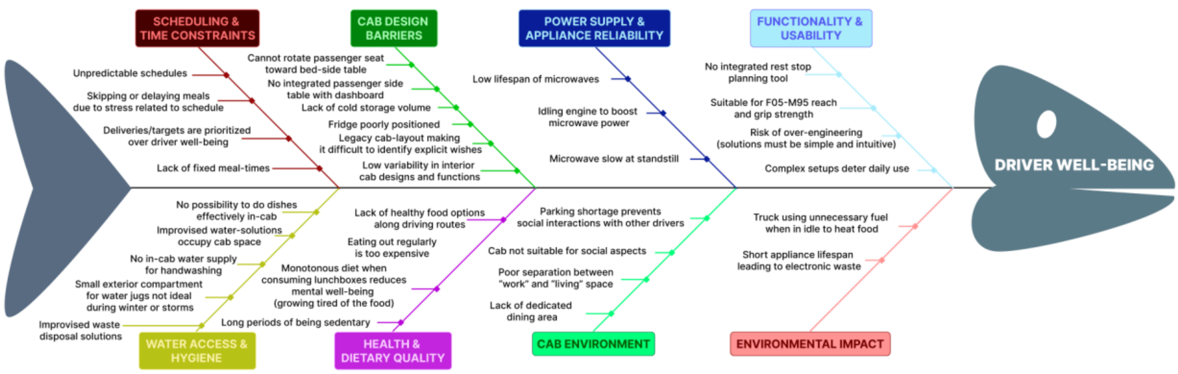


Figure 25. Ishikawa Diagram showing the identified problems.

From the Ishikawa Diagram analysis, three branches were identified as the most directly actionable within the project scope and most relevant to the decision to focus concept development on the cab interior.

The branch of physical cab design barriers groups the physical limitations most consistently raised across the interviews. The absence of a stable eating surface on the passenger side which is a standard feature on Scania's trucks but absent from the Volvo FH was the most widely articulated explicit design gap, reaching seven of ten participants. Related problems include the refrigerator being positioned too far from the driver, insufficient cold storage volume for multi-day provisioning, and the inability to rotate the passenger seat toward a table. These are all causes that can be directly addressed through changes to the cab interior layout, making this branch the strongest argument for an interior focused concept direction.

The branch of health and dietary quality draws together findings related to eating habits and the long-term well-being consequences of the long-haul diet. Meal monotony emerged as a persistent source of reduced well-being where drivers who meal-prep for the full working week eat the same dish every day out of practical necessity rather than preference. Additionally, healthy options at roadside stops were described as rare or too expensive to eat at regularly. These findings point directly to the value of a better-organized and more capable in-cab food environment focused on improving cold storage access, eating surfaces, and preparation surfaces.

The branch covering the cab environment captures the dimension of driver well-being that extends beyond individual food preparation into the residential character of long-haul work. Drivers spend multiple consecutive nights per week in the cab, and the quality of the lounge and eating environment has a direct impact on their well-being. The absence of a dedicated lounge or seating group, the inability to eat comfortably without facing the dashboard, and the lack of space for social meals with colleagues are all causes that point conclusively to the cab interior as the most impactful area of intervention.

4.2 Customer needs list

Customer needs have mainly been derived from the survey and interviews and has been supplemented by previously identified customer needs from Volvo Trucks for the interior of the Volvo FH cab. The identified needs have been classified as explicit or latent depending on whether they were directly articulated by the participant or derived from workarounds, frustrations or behavioural patterns that were not directly framed as a product request. The list consists of a primary need describing the general area that the need targets, such as "cab interior", and the description outline the need derived from the pre-study. The full customer needs list can be found in Figure 26.

Nr.	Need/wish	Description	Imp.	Type	Notes
Cab interior					
1	Wish	Separate driving space from living space	4	Explicit	Cab interior should feel like a home instead of a work space
2	Wish	Flat surfaces to put items temporarily	4	Explicit	E.g. dashboard, tables
3	Wish	Easily cleaned surfaces	3	Explicit	Ensure hygienic environment
4	Wish	Waste collection solution inside the cab	4	Implicit	Users currently utilize plastic bags
5	Wish	Running water	4	Explicit	Wash-basin inside or outside cab
6	Need	Good storage opportunities for food and drinks	5	Explicit	Based on results of the pre-study
7	Wish	Lounge area	4	Explicit	Lounge area to disconnect from the driving aspect of the job
8	Wish	Seamless integration of solution with rest of cab	4	Implicit	
Ergonomics					
9	Wish	Should not have to hunch over to prepare or eat food	4	Explicit	Ergonomic seating area for eating meals should be available
10	Wish	Dashboard table	4	Explicit	Table that extends from the dashboard on the passenger side
11	Need	Low complexity and high usability solutions	5	Explicit	Cognitively ergonomic
Power & Appliances					
12	Need	Microwave that operates at full power without engine running	5	Explicit	Running the engine solely to heat food is both inconvenient and environmentally problematic. Inverters are commonly used
13	Need	Have power for electrical appliances	5	Explicit	Should be able to power electrical appliances used for food preparation without idling truck
14	Wish	Durable microwave suited to truck vibration and daily usage	4	Explicit	Microwave failure is common and they are expensive to replace
15	Wish	Modular interchangability between appliances	2	Implicit	Swap out appliances easily through modular systems
16	Wish	Effective ventilation	3	Implicit	Ventilation to reduce odor when cooking
Food storage & preparation					
17	Need	Easy-to-reach storage opportunities	5	Explicit	The driver should not have to divert their attention from the road if reaching while driving. Should be suited for F05-M95
18	Need	Refrigerator with capacity for multi-day provisioning	5	Explicit	Current Volvo trucks on the market lack a table on the passenger side leading to the user having to hunch over the dashboard or use the bed-side table
19	Need	Good accessibility for drinks while driving	5	Explicit	Should not have to divert attention from the road to reach the drink
20	Need	Easy process for preparing food	5	Explicit	The meal preparation process should not be overly complicated and suitable for use when under time pressure
21	Wish	Appliance and meal container combination	4	Latent	Appliances adapted to a specific type of meal containers that ensure maximum storage and packaging capability, reducing "dead space"
22	Wish	Refrigerator positioned close to driver seat	4	Explicit	Refrigerator drawer is currently placed next to the passenger side
23	Wish	Portable kitchen setup	3	Latent	Setup which allows you to cook your own food from scratch while in the truck
24	Wish	Food preparation opportunities	3	Explicit	Through other means than heating with a microwave
25	Wish	Access to running water in connection to the interior or exterior of the cabin	4	Explicit	Manage dishes and improve hygiene
26	Wish	Refrigerator and freezer setup	4	Explicit	divider takes up too much space
Cab exterior					
27	Wish	Outdoor cooking support (grill setup)	4	Explicit	An integrated grill setup for use outside the truck during summer
28	Wish	External lighting for evening stops	2	Explicit	Relevant for outdoor eating, hygiene tasks, and general safety at rest stops.
29	Wish	Wash basin/shower module	3	Explicit	
Digital Tools					
30	Wish	Integrated rest stop and parking planner in infotainment system	4	Explicit	Similar to Tesla's charging planner, would aid in finding suitable stops for parking, food and facilities
31	Wish	Reliable digital tool or database for locating truck friendly stops	3	Explicit	A curated database updated with correct information applied via the infotainment system
Sustainability					
32	Need	Long lifecycle of appliances	5	Explicit	Last for minimum of 3 years, failure is expected and tolerated more than with home appliances
33	Wish	High power for electrical appliances without turning on the truck	4	Explicit	Negative impact on environment having the truck in idle to increase output of appliances
Safety					
34	Need	Food preparation appliances should not be fire or gas hazardous	5	Explicit	Appliances must be properly installed and ventilated
35	Need	Storage modules should be securely mounted	5	Explicit	Lockers or drawers should not open in case of hard breaking or similar scenarios
36	Need	Cab must be able to tilt forward	5	Explicit	Securely mounted and adapted solutions

Figure 26. Full customer needs list.

Based on the customer needs list, the identified needs were organized into distinct categories, as presented in Figure 27.

Category	Sub-category
Interior	Dish management
	Eating space / lounge area
	Food storage
	Food preparation
Exterior	Food support
	Hygiene
User Interface	Parking opportunities
	Appliances

Figure 27. The main categories with their respective sub-categories.

The subcategories serve to provide a more detailed representation of the specific needs within each overarching category. For instance, while the interior category encompasses a broad range of potential needs, subcategories such as dish management offer a more precise characterization of the needs identified through the interviews and questionnaire.

4.3 Personas

Personas were used to summarize and visualize the results from the interviews, providing an overall picture of the main issues, current eating habits, and users' needs, which can be seen in Figure 28 below. The personas were based on the interviewees, where there were three female drivers and seven male drivers, which led to the decision to create two male personas and one female.

Figure 28. The three personas developed from the interviews.

The anthropometric measurements for the personas, as in weight and height, were based on a woman in the 5th percentile and two males in the 50th and 95th percentiles (Högskolan i Skövde, n.d.), which were later implemented in the ergonomic analysis of the final concept. The personas were also used as a basis for evaluating the concept configurations in the later stages of the concept screening phase.

The personas gave a summary of the main problems experienced by the interviewees, as well as the customer needs which was later used in the concept generation phase.

4.4 User Journey Mapping

Based on one of the personas, a user journey map was created, which can be seen in Figure 29 below. The results from the interviews indicated that the younger interviewees, particularly the females, defined more problems and pain points and suggested more for improvements. This led to the decision to base the user journey map on the female persona.

The map displays the activities over a workday, and the associated preparations were analyzed with regard to the emotions experienced by the persona, the thoughts that arose during each activity, the physical objects the persona interacted with, as well as identified pain points and opportunities. The activities, as well as the emotions, thoughts, physical objects, and pain points, were based on the interviews conducted and provided valuable insight into how the various actions are carried out, which in turn led to the identification of additional customer insights.

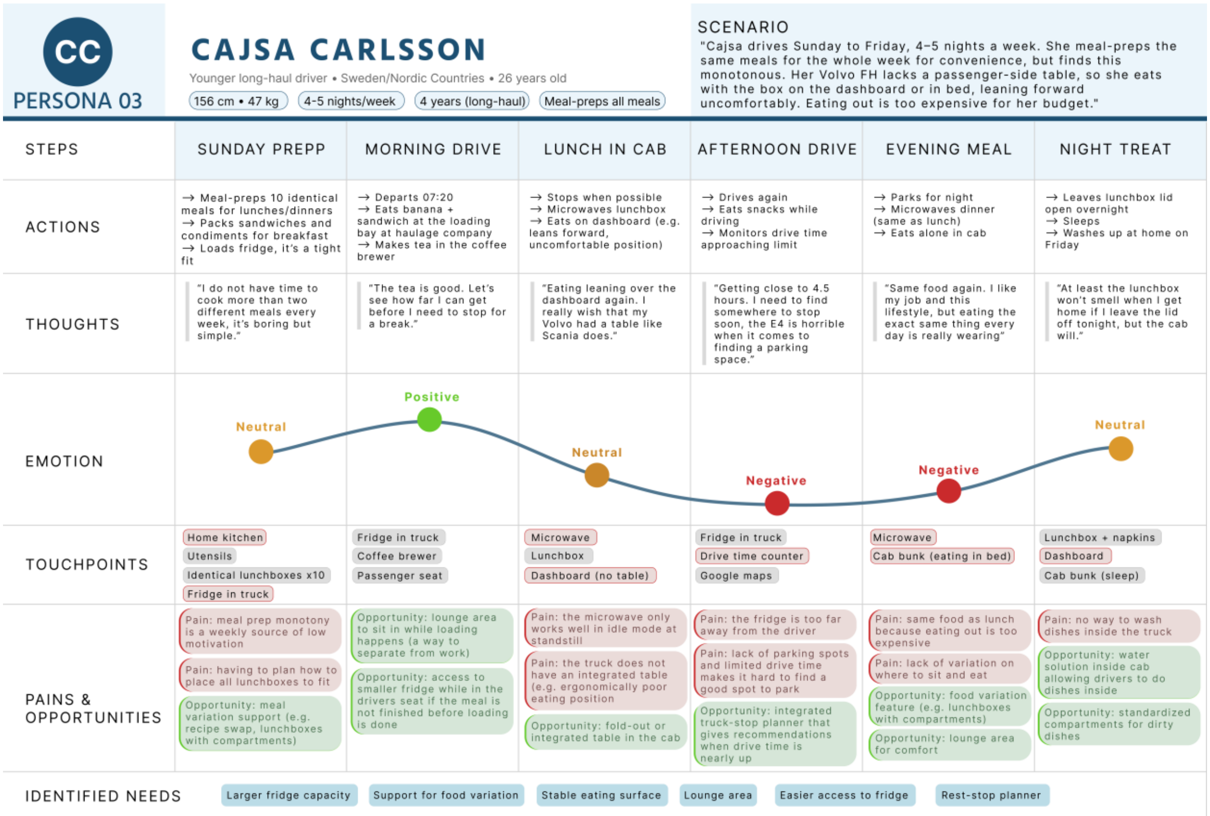


Figure 29. User Journey Map for persona 3.

The user journey map served as a continuous reference point throughout the project but also contributed to a deeper understanding of the concrete actions performed by the user, something that proved particularly valuable during the brainstorming and brainwriting phases of concept development. In addition to its contribution to concept development, the tool facilitated collaboration within the team at Volvo by ensuring that all members maintained a consistent user perspective, which promoted well-founded decision-making.

4.5 Summary of the Customer Needs Analysis Olivia

The Customer Needs Analysis contained a comprehensive analysis of the interview data, identifying and highlighting the actual needs/wishes and problems that long-haul drivers in Northern Europe encounter in their daily work life. The data analysis on the interviews revealed a coherent picture of the long-haul driver's relationship with food and living habits that differs in several important ways from initial assumptions. The primary insight is that in-cab food preparation is not the main source of dissatisfaction, or at least not among most Swedish long-haul drivers as they were largely content with the microwave and fridge setup, lacking any desire to cook inside the cab using other appliances. Instead, the dominant pain points are structural and include parking availability, scheduling unpredictability, and the absence of ergonomic eating conditions which were found to cause poor body posture and low reachability when using eating surfaces. The majority of the revelations made in the customer needs analysis mostly fall out of the area of this thesis work. However, it is simultaneously difficult for people to know what they like or dislike before they have had the chance to even try it.

A second key finding is that simplicity is the overriding design principle. Every participant independently emphasized that any new solution should integrate seamlessly into existing routines without adding complexity. This places a strong constraint on the concept generation phase where solutions that require preparation time, new habits, or additional equipment are likely to face resistance. As the Gioia aggregate dimension “Barriers to regular eating habits” illustrates, drivers have already developed effective personal systems with improvised eating surfaces, personal water jugs, weekly lunchbox planning, meaning that any new feature must complement rather than disrupt these routines. Problem areas were further highlighted by the thematic coding and expanded upon through the Ishikawa Diagram, allowing a coherent overview over the most pressing issues.

Third, the interviews confirmed that water access and hygiene are underserved relative to their importance. While refrigeration and microwaves are already well-integrated, water remains an improvised solution consisting of large jugs or multiple bottles, suggesting a meaningful design opportunity. This points to a meaningful design opportunity that corresponds directly to the highly prevalent need “Water solution for hygiene, running or easy-access water” in the thematic coding and the Gioia theme of hygiene routines managed through workarounds. Another important aspect identified through the interviews is the desire to separate the driving space of the cab with the living space, allowing the drivers to have an area where they can relax without the stress and feeling of being confined in a truck. Finally, the social and outdoor dimensions of eating are more significant than expected. Eating together at rest stops during summer and grilling outdoors was both practiced and desired by several drivers, suggesting that product concepts limited to the cab interior may miss an opportunity to support driver well-being more holistically.

The most frequently occurring needs and wishes identified in the customer needs list, in combination with the general demographic information provided by the interviewees, such as age and gende, were used to develop three distinct personas. These personas were assigned an anthropomorphic range corresponding to the intended scope of the final concept, which was designed to accommodate users ranging from females at the 5th percentile to males at the 95th percentile. Based on one of the established personas, specifically the female persona, a user journey map was created to discern which activities related to eating and food habits were carried out over the course of a working day. The activities were derived from the interviews conducted with female respondents, who demonstrated a higher frequency of both reported concerns and proposed improvements. These findings were incorporated into the user journey map through the inclusion of emotional states and potential pain points. From the identified pain points, corresponding opportunities were subsequently derived, which were then used in the idea generation.

5 Requirement Specification

A requirement specification has been developed based on the outcomes of the pre-study and internal requirements relating to Volvo's cab interior. See Appendix E.

6 Concept Generation

The concept generation chapter covers the process that has been followed to generate concepts, including results from brainstorming, co-creation workshops and a morphological matrix.

6.1 Idea Generation

The idea generation began at early stages of the thesis work. After reviewing literature regarding truck driver well-being, potential solutions for the identified problems were documented as a basis for later phases of the project. The literature review also had significant influence on the problem statement and served as the foundation for the research questions and the survey. Furthermore, the results from the questionnaire corroborated that the problems that were documented from the literature review, had a negative effect on the drivers well-being. It was not until the interviews and the subsequent analysis had been conducted that the problematic areas were placed in a broader perspective, which prompted the first reorientation of the project. The ideas that were initially generated were largely concentrated on food preparation and on-board cooking capabilities, which proved to be in low demand among the drivers.

This led to a second iteration of idea generation which began with brainstorming sessions based on the results from the interview analysis and the user journey map. The ideas were documented and categorized according to the categories compiled in the customer needs analysis, which can be seen in Figure 30.

Category	Sub-category	Feature
Interior	Dish management	Dishwasher integrated into storage under bed
		Sink under bed
		Sink instead of passenger seat
		Storage for dirty lunchboxes
	Eating space / lounge area	Sofa bed
		Foldable bed
		Table in dashboard
		Fully rotating passenger seat
		Foldable table
		Table in back of passenger seat
	Food storage	Storage for food related items
		Small fridge in dashboard
		Small fridge in car door
		Fridge with rails
		Cooling drink holder
		Custom lunchboxes for existing fridge
	Food preparation	Airfryer integrated into truck cabin interior
		Induction stove for use inside truck cab
		In-cab water supply for food
		Microwave connected to infotainment system
Exterior	Food support	Modular cooking unit in outer storage
	Hygiene	Sink placed in outer storage
User Interface	Parking opportunities	Parking spot locator
		Journey planner
	Appliances	Voice or infotainment controlled appliances

Figure 30. The solutions divided into different categories.

These ideas were partially aligned with those initially generated prior to the interviews. However, the scope had broadened to encompass more unconventional concepts, such as user interface solutions, thereby allowing for greater consideration of the user's perspective. This also led to the decision to continue the idea generation with a more open mind and not exclude certain aspects, such as exterior of food preparation, given that they aligned both with the insights gathered from the users and with the original objectives of the project.

Following the brainstorming sessions and the subsequent categorization of ideas into features, a brainwriting session was conducted with the purpose of visualizing the generated features through sketching. The resulting sketches served as a valuable aid in developing an understanding of how the individual features would function, as well as how they could feasibly be implemented within the cab environment. A compilation of the feature concepts generated for the interior, exterior, and user interface are presented in Figures 31, 32, and 33 respectively.

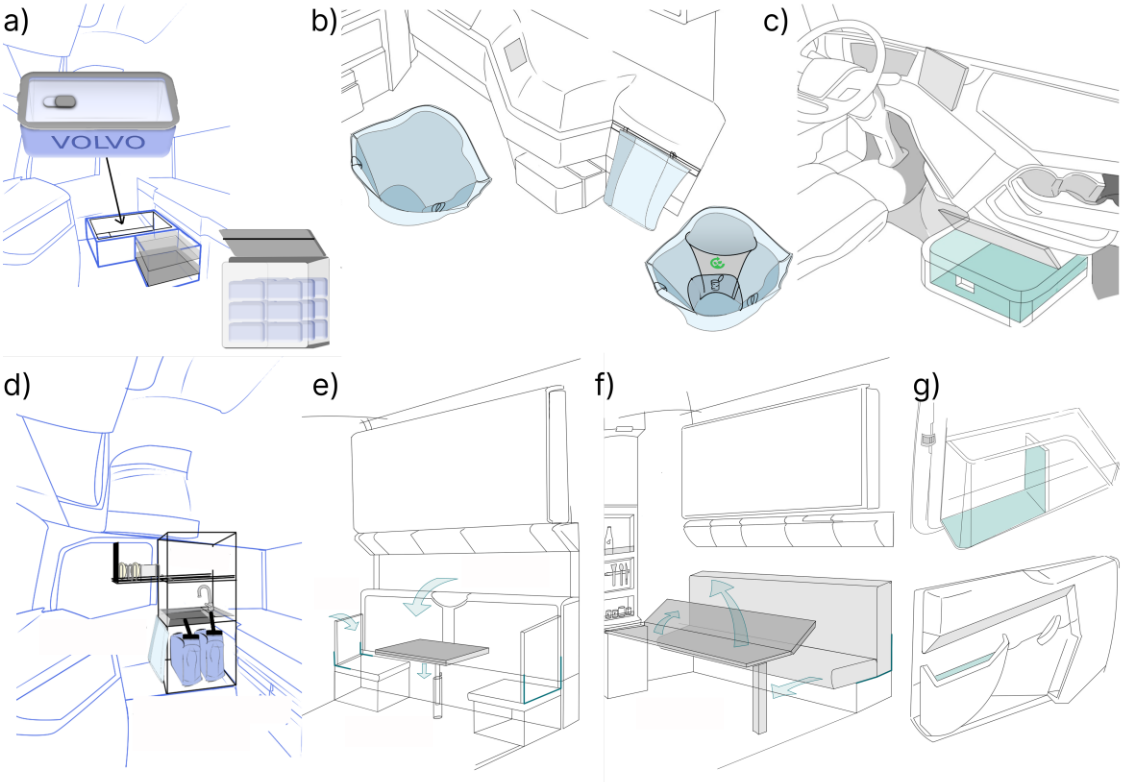


Figure 31. Compilation of interior concepts.

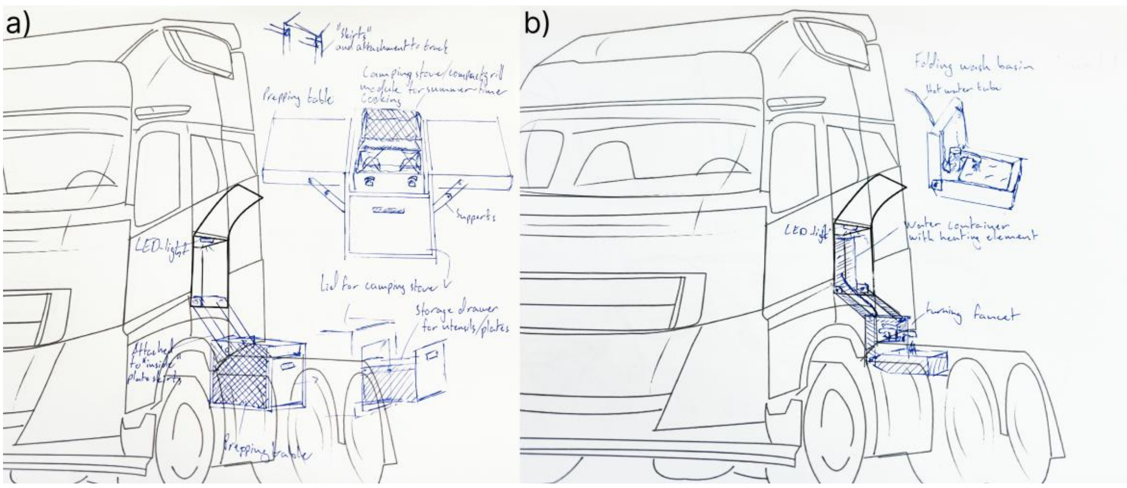


Figure 32. Compilation of exterior concepts.

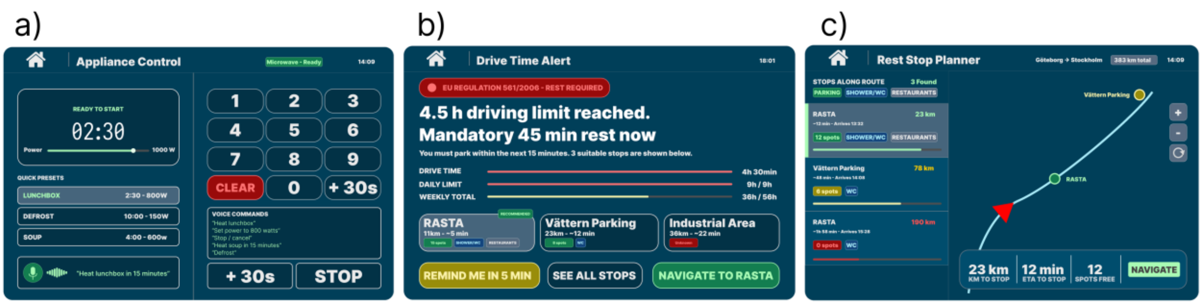


Figure 33. Compilation of User Interface concepts

These sketches, in conjunction with the customer needs list, also served as a reference when presenting the conceptual options to the Ergonomics team for further evaluation. This evaluation aimed to determine which concept category to pursue, including whether the focus should be directed towards accessories such as lunchboxes, integrated features such as a driver-side refrigerator, or alternative cab layout configurations.

Based on the input from the ergonomics team at Volvo, the concept development area best suited to the scope of the thesis is directly related to solutions in the cab interior, rather than exterior or user interface solutions. Exterior features such as an outdoor grill station or water basin, and digital solutions such as a rest stop planning tool, address real needs. However, the physical cab design barriers, dietary quality concerns, and living environment collectively represent unmet needs that can be resolved through interior design changes alone. After evaluations with the team, the area best suited to focus on for the concept development phase is best defined as the eating space/lounge area.

6.2 Co-Creation Workshop

The co-creation workshop was held with experts of the subject matter at Volvo Trucks and aimed to achieve two things: Identify current problems that affect truck drivers in different aspects of life, and generate ideas catered to solving issues related to food-handling. The workshop began with a structured problem identification exercise in which each participant wrote individual problems on post-it notes, which were categorized under six aspects affecting driver well-being: food, mental activity, physical activity, sleep, social activity, and other. The identified problems across all areas are shown in figure 34, where each expert is represented by their own colour.

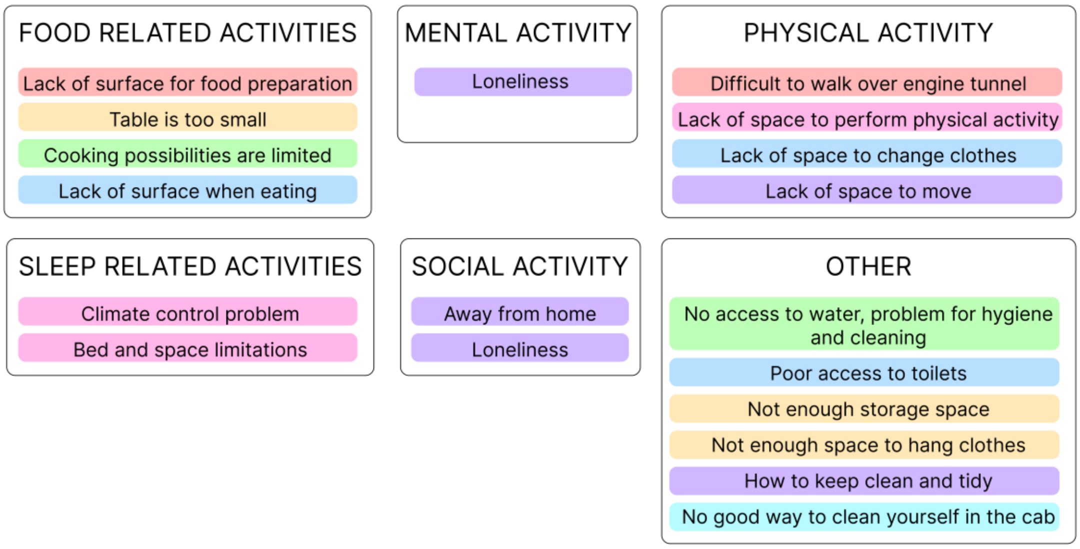


Figure 34. Problem areas identified in the co-creation workshop, where each expert is represented by their own color.

To link the subsequent idea generation to real driver data that had been collected, selected results from the survey were presented to the group. Among these results were the finding that despite 33 out of 47 survey respondents bringing home-cooked meals to work. Additionally, 15 participants identified food habits alongside stress, sleeping habits, and working conditions as having the biggest negative impact on their well-being. This finding directly reinforced the conclusions of the literature review and interview analysis, both of which indicated that drivers' food habits and the conditions under which they eat represent a meaningful area for design intervention.

To tackle the identified problems the experts were given a task to generate different solution ideas through sketching or describing them, followed by explaining how the solution is meant to work, and ultimately listing the user benefits from the solution. To aid them in the idea generation a set of guiding images were used to help spark ideas. See Figure 35.

Figure 35. Inspiration for idea generation.

The co-creation workshop yielded six concepts aimed at the identified problem areas, shown in Figure 36. The concepts addressed several of the problems that had emerged consistently throughout the pre-study, including ergonomics related to posture and reach while eating, food storage, and water management. The results of the co-creation workshop provided a qualitative complement to the findings gathered earlier in the project.

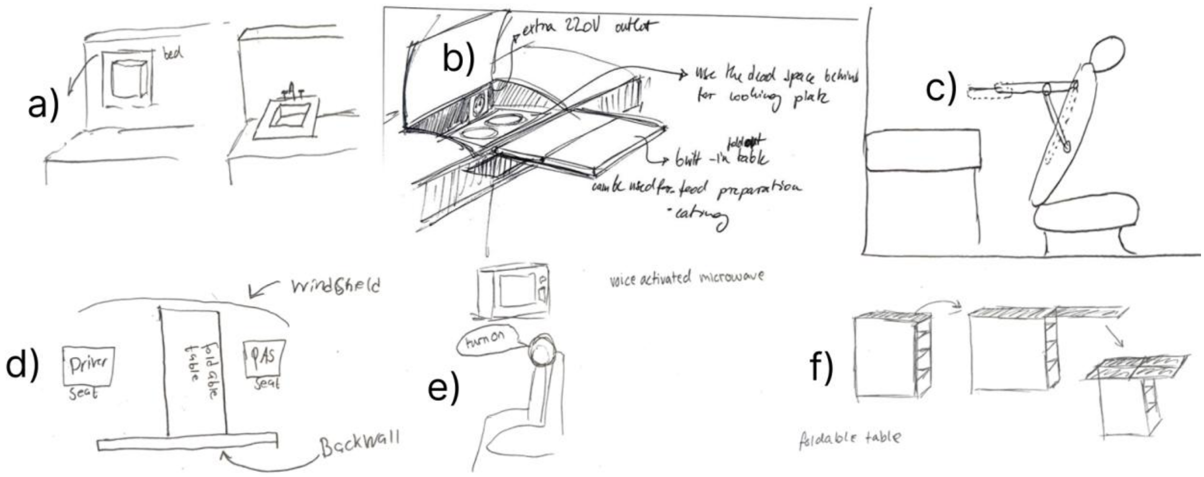


Figure 36. Compilation of concepts generated in the co-creation workshop.

6.3 Function Tree Analysis

The function tree analysis consists of a main function which branches off into nine separate sub-functions which contain a set of sub-solutions. The main function, “Enable integrated in-cab living space for eating and resting” was chosen based on the results of the Interview

Analysis in chapter 3.2.1, and the Requirement Specification from chapter 3.3. The nine sub-functions were selected because they each represent a distinct dimension of the main function. This structure mirrors the logic of Ulrich and Eppinger's (2012) concept classification tree, where independent sub-problems are separated so that solutions to one dimension can be varied freely without constraining the options available in another.

The sub-solutions within each sub-function range from existing market-available configurations to more conceptual alternatives. The cold storage sub-function, for example, ranges from the standard fridge already present in the Volvo FH16 to additional modular fridge setups, and a mini-fridge integrated in the driver door, a sub-solution that emerged directly from interview participants describing a desire to keep snacks accessible from the driver position without leaving the seat. Similarly, the water management sub-function ranges from minimal intervention to high-integration solutions. This sub-function reflects a strong finding from the interview analysis where seven of ten participants had developed improvised personal water management systems, discovering an unmet need that the current cab design does not address through any integrated solution. The eating surfaces sub-function illustrates the direct translation from customer need to sub-solution particularly clearly. The need for a stable, flat eating surface on the passenger side was raised by seven out of ten participants and identified as a concrete competitive disadvantage relative to Scania. The sub-function is addressed through five distinct sub-solutions such as a foldable table, a raisable table, a stationary table, a dashboard table, and an extendable table. Each represents a different trade-off between stability, space efficiency, and complexity. By using a function tree diagram and keeping sub-solutions separated rather than collapsing them into a single category ensures that the trade-offs can be evaluated independently during the subsequent morphological matrix and concept screening phases. See figure 37 for the function tree analysis.

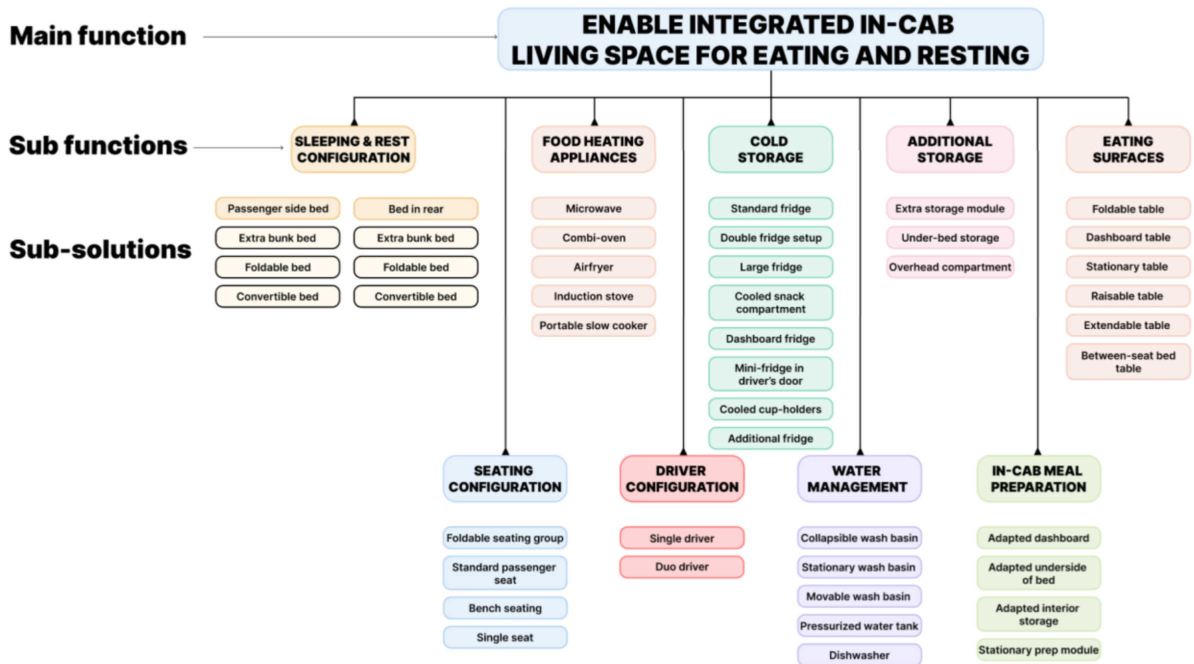
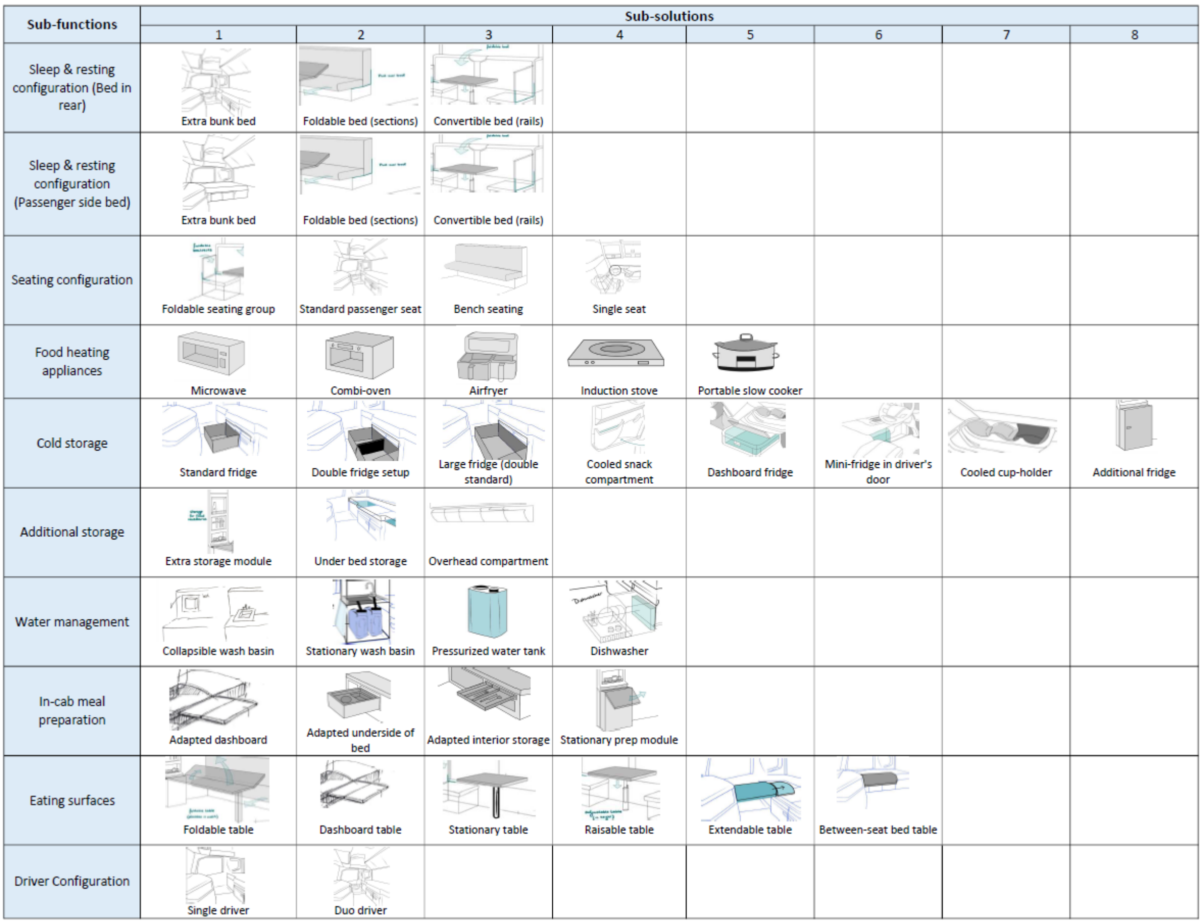


Figure 37. Function tree diagram.

6.4 Morphological Matrix

A Morphological Matrix was created based on the function tree analysis and supplemented with images of the sub-solutions, as shown in figure 38.



Sub-functions	Sub-solutions							
	1	2	3	4	5	6	7	8
Sleep & resting configuration (Bed in rear)	Extra bunk bed	Foldable bed (sections)	Convertible bed (rails)					
Sleep & resting configuration (Passenger side bed)	Extra bunk bed	Foldable bed (sections)	Convertible bed (rails)					
Seating configuration	Foldable seating group	Standard passenger seat	Bench seating	Single seat				
Food heating appliances	Microwave	Combi-oven	Airfryer	Induction stove	Portable slow cooker			
Cold storage	Standard fridge	Double fridge setup	Large fridge (double standard)	Cooled snack compartment	Dashboard fridge	Mini-fridge in driver's door	Cooled cup-holder	Additional fridge
Additional storage	Extra storage module	Under bed storage	Overhead compartment					
Water management	Collapsible wash basin	Stationary wash basin	Pressurized water tank	Dishwasher				
In-cab meal preparation	Adapted dashboard	Adapted underside of bed	Adapted interior storage	Stationary prep module				
Eating surfaces	Foldable table	Dashboard table	Stationary table	Raisable table	Extendable table	Between-seat bed table		
Driver Configuration	Single driver	Duo driver						

Figure 38. Full Morphological Matrix with sketches to provide better understanding of the sub-solutions.

Entering all sub-functions and sub-solutions from the function tree analysis into Morpheus (Martinsson Bonde, 2021) generated 2160000 possible combinations. As this volume is far too big to evaluate, a reduction process was applied before concept screening could begin to make the number of generated concepts more feasible. In the first stage, 60 incompatibilities between sub-solutions across different sub-functions were identified and encoded into the tool, see Appendix F.1. Incompatibilities were defined as combinations where the combination of two sub-solutions would be physically infeasible, ergonomically unsafe, or structurally impossible within the cab envelope. Examples include the combination of an extra bunk bed with an overhead compartment, both of which compete for the same vertical volume above the lower bunk. Another example is the combination of a dishwasher with a double fridge setup, where both units simultaneously exceed the available floor and wall space in any current Volvo FH16 XXL cab configuration. Each incompatibility was reasoned against known cab dimensions, hardware dimensions, and the constraints identified in the requirement specification.

In the second stage, a number of sub-functions and sub-solutions were removed due to not aligning with the project scope and lack of relevance to the main function. Water management was removed as a sub-function at this stage because, while it was identified as an important latent need in the interview analysis, the integration of a functional water system requires a level of plumbing infrastructure that falls outside the feasibility boundaries of this project. Similarly, in-cab meal preparation sub-solutions were reduced following the clear finding from the pre-study that drivers show no interest in cooking inside the cab, which meant that the presence of elaborate preparation zone sub-solutions in the matrix would have produced concepts that did not reflect actual driver needs. Extra bunk bed sub-solutions were also removed, as the target demographic for this project is overwhelmingly single-driver operators, and bunk configurations primarily serve fleet duo-driver setups, shifting the design focus away from the resting comfort and lounge quality goals that the main function establishes.

Following these reductions, the total concept pool was brought down to 320. Of these, 93 represented configurations suited to duo-driver setups. Duo-driver cab interiors are already well-served by existing market offerings, and since the design opportunity identified through the interview analysis and customer needs analysis lies specifically in single-driver layouts that prioritize resting comfort and lounge quality, the 93 duo-driver concepts were set aside. The remaining 227 single-driver concepts were carried forward for evaluation through the elimination matrix. The reduced morphological matrix is shown in Figure 39, and the complete concept catalog of 227 concepts is available in Appendix F.2.

Sub-functions	Sub-solutions			
	1	2	3	4
Sleep & resting configuration	Convertible bed rear	Foldable bed rear	Convertible bed passenger side	Foldable bed passenger side
Seating configuration	Foldable seating group	Standard passenger seat	Bench seating	Single seat
Cold storage	Standard fridge	Dashboard fridge	Additional fridge	
Additional storage	Extra storage module	Under bed storage	Overhead compartment	
In-cab meal preparation	Adapted dashboard	Adapted underside of bed		
Eating surfaces	Foldable table	Dashboard table	Extendable table	
Driver Configuration	Single driver	Duo driver		

Figure 39. Reduced Morphological Matrix.

7 Concept Screening and Selection

The concept selection phase followed a structured series of matrices based on methods described by Ulrich and Eppinger (2012). The concept selection phase was performed to limit the amount of concepts with evaluation matrices that are built upon set criteria to eliminate concepts that do not fulfill the set criteria.

7.1 Elimination Matrix

The Elimination Matrix was used as a method to reduce the number of concepts generated by the Morphological Matrix into a more manageable amount for further evaluation. The method provided a structured approach to eliminating unsuitable concepts from a large solution field by determining if they should be removed or continue based on whether they fail or succeed in fulfilling the criteria. The evaluation revealed consistent patterns in which specific sub-solutions caused elimination across all concepts in which they appeared. An evaluation of the sub-solutions found in each concept was performed based on whether or not they fulfill the criteria, if the sub-solution did not meet any of the specified criteria, every solution containing it failed and was removed from the Elimination Matrix. See table 9.

Table 9. Sub-solutions that did not fulfill the criteria in the Elimination Matrix.

Criteria	Sub-solution	Evaluation	Justification
Lounge quality	Single seat	Fail	A single seat provides no facing or social seating arrangement, which is foundational to a lounge configuration
Ergonomic usability	Adapted storage under bed	Fail	Accessing under-bed storage in an adapted configuration requires sustained bending and crouching, placing the movement outside an ergonomically acceptable range for regular daily use
Implementability	Convertible bed passenger side	Fail	Confidential
Storage efficiency	Under-bed storage with convertible bed	Fail	The mechanism of the convertible bed reduces the usable floor and wall volume beneath the bunk to below a functional minimum
	Dashboard table	Fail	When deployed, the dashboard table occupies the forward cab surface zone reducing the effective storage
Spatial Efficiency	Raisable table	Fail	Requires floor or wall mounting infrastructure that reduces usable space
	Bench seating	Fail	Bench seating occupies a significant floor and rear wall footprint that conflicts with the spatial requirements of the rear bed and walkthrough clearance
	Overhead compartment	Fail	An additional overhead module would create a redundant doubling of this feature

The identification of sub-solutions that did not fulfill the criteria reduced the number of concepts from 227 to 22 passing concepts. The full Elimination Matrix is available in Appendix G.1.

7.2 Pugh Matrices

The next step of the concept screening process consisted of a series of Pugh Matrices to further reduce the number of concepts remaining. Three iterations of the Pugh matrix were performed in total, with each iteration using a different concept as the reference against which all others were scored. The criteria, scoring logic, and motivations were held constant across all three iterations, relying on a guide template containing the sub-solutions and how they compare against the relevant criteria. See figure 40.

Perceived Lounge Quality	Foldable bed side < Foldable bed rear/convertible bed
	Standard fridge < Dashboard fridge/Additional fridge
	Storage under bed < Extra storage module
	Foldable table < Extendable table
	All concepts are better than FH16 as they offer greater lounge quality
Driver adoption	Foldable table < Extendable table
	Foldable bed < Convertible bed
Resting configuration	Convertible bed < Foldable bed
Ease of drive-to-rest transition	Foldable bed side < Foldable bed rear < Convertible bed
Meal preparation capability	Extra storage module + extendable/foldable table > under bed storage
Eating space quality	Bed side < Bed rear
	Extendable table < Foldable table
Storage capacity	Convertible bed < Foldable bed rear
	Foldable bed side < Foldable bed rear
	Storage under bed < Extra storage module.
Cold storage capacity	Storage under bed < Extra storage module.
	Standard fridge < Dashboard fridge < Additional fridge
Walkthrough clearance	Extra storage module < Storage under bed
	Foldable table < Extendable table
	Foldable bed rear < Foldable bed side < Convertible bed
Complexity of construction	Extendable table < Foldable table
	All are more complex than the FH16 Aero XXL cab
	Foldable bed side < Convertible bed < Foldable bed rear
	Dashboard fridge < Additional fridge < standard fridge
	Underbed storage < Extra storage module

Figure 40. Justification of sub-solutions ranked against the criteria.

To determine the comparative scores, the performance of each sub-solution against each criterion was assessed individually before being translated into the +, 0, or - scores featured in the matrix. An example of this sub-solution performance mapping is shown in Figure 41 for the complexity of construction criterion in the third iteration, where red indicates a sub-solution that performs worse than the reference, yellow indicates equal performance, and green indicates better performance. The accumulated performance across all sub-solutions in a concept determined the final score given to the concept.

#	Bed Configuration	Seating configuration	Cold storage	Additional storage	In-cab meal preparation	Eating surfaces	Driver configuration
52	Convertible bed rear	Foldable seating group	Dashboard fridge	Extra storage module	Adapted dashboard	Extendable table	Single driver
54	Convertible bed rear	Foldable seating group	Dashboard fridge	Extra storage module	Adapted dashboard	Foldable table	Single driver
61	Convertible bed rear	Foldable seating group	Standard fridge	Extra storage module	Adapted dashboard	Extendable table	Single driver
63	Convertible bed rear	Foldable seating group	Standard fridge	Extra storage module	Adapted dashboard	Foldable table	Single driver
109	Foldable bed rear	Foldable seating group	Dashboard fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
111	Foldable bed rear	Foldable seating group	Dashboard fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
115	Foldable bed rear	Foldable seating group	Dashboard fridge	Extra storage module	Adapted dashboard	Extendable table	Single driver
117	Foldable bed rear	Foldable seating group	Dashboard fridge	Extra storage module	Adapted dashboard	Foldable table	Single driver
127	Foldable bed rear	Foldable seating group	Standard fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
129	Foldable bed rear	Foldable seating group	Standard fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
133	Foldable bed rear	Foldable seating group	Standard fridge	Extra storage module	Adapted dashboard	Extendable table	Single driver
135	Foldable bed rear	Foldable seating group	Standard fridge	Extra storage module	Adapted dashboard	Foldable table	Single driver
202	Foldable bed passenger side	Foldable seating group	Additional fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
203	Foldable bed passenger side	Foldable seating group	Additional fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
210	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
211	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
214	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Extra storage module	Adapted dashboard	Extendable table	Single driver
215	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Extra storage module	Adapted dashboard	Foldable table	Single driver
222	Foldable bed passenger side	Foldable seating group	Standard fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
223	Foldable bed passenger side	Foldable seating group	Standard fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
226	Foldable bed passenger side	Foldable seating group	Standard fridge	Extra storage module	Adapted dashboard	Extendable table	Single driver
227	Foldable bed passenger side	Foldable seating group	Standard fridge	Extra storage module	Adapted dashboard	Foldable table	Single driver

Figure 41. Performance of sub-solutions for "Complexity of Construction" criteria with concept 115 as reference.

The first iteration used the current Volvo FH16 Aero XXL as the reference, establishing the production baseline against which all 22 concepts were compared. All concepts scored positively on lounge quality, driver adoption, resting configuration, ease of drive-to-rest transition, eating space quality, and walkthrough clearance relative to the current cab. The differentiating criteria in this iteration were cold storage capacity, storage capacity, and meal preparation capability, where scores varied depending on the specific cold storage and storage sub-solutions in each concept. All concepts scored negatively on complexity of construction, as every concept introduces additional mechanical elements beyond the current standard cab. For the first iteration of the Pugh Matrix, see Appendix G.2.

The second iteration used Concept 52 which was the strongest performer from the first iteration as the new reference. With a stronger reference, most concepts scored negatively on the majority of criteria in the second iteration. Concepts C115 and C133 emerged as the strongest performers with a total sum of +1, driven primarily by their superior resting configuration score as foldable bed sections provide greater flexibility between sleeping and sofa mode than the convertible rail bed of the reference concept. Passenger-side bed concepts scored consistently poorly due to their lower scores on lounge quality and walkthrough clearance relative to the reference. For the second iteration of the Pugh Matrix, see Appendix G.3.

The third and final iteration used Concept 115 as the reference, which was the highest scorer in the previous iteration. At this stage, differentiation narrowed primarily to the distinction between rear bed types and table types. The convertible bed concepts from C52 and C54 scored positively on ease of drive-to-rest transition and driver adoption relative to the reference, but negatively on resting configuration and storage capacity. The third iteration Pugh matrix is shown in Figure 42.

Pugh Matrix Third Iteration — Criteria / Concepts	Concept 115	Volvo FH16 Aero XXL	Concept 52	Concept 54	Concept 61	Concept 63	Concept 109	Concept 111	Concept 117	Concept 127	Concept 129	Concept 133	Concept 135	Concept 202	Concept 203	Concept 210	Concept 211	Concept 214	Concept 215	Concept 222	Concept 223	Concept 226	Concept 227
Perceived lounge quality		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Driver adoption	R	-	+	0	+	0	0	-	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
Resting configuration	E	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ease of drive-to-rest transition	F	-	+	+	+	+	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
Complexity of construction	E	+	-	0	0	+	-	0	+	0	+	+	+	-	0	-	-	-	0	-	0	-	0
Meal preparation capability	R	-	0	0	0	0	-	-	0	-	-	0	0	-	-	-	-	0	0	-	-	0	0
Eating space quality	E	-	0	+	0	+	0	+	+	0	+	0	+	-	0	-	0	-	0	-	0	-	0
Storage capacity	N	-	-	-	-	-	-	-	0	-	-	0	0	-		-	-	-	-	-	-	-	-
Cold storage capacity	C	-	0	0	-	-	-	-	0	-	-	-	-	0	0	-	-	0	0	-	-	-	-
Walkthrough clearance	E	-	+	0	+	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-
∑ +	0	1	3	2	3	3	0	1	2	0	2	1	2	0	0	0	0	0	0	0	0	0	0
∑ -	0	9	4	3	4	4	6	6	3	5	6	2	4	7	6	8	8	4	5	8	7	7	6
∑ 0	0	0	3	5	3	3	4	3	5	5	2	7	4	3	4	2	2	6	5	2	3	3	4
Total Sum	0	-8	-1	-1	-1	-1	-6	-5	-1	-5	-4	-1	-2	-7	-6	-8	-8	-4	-5	-8	-7	-7	-6
Decision	Continue	Remove	Continue	Remove	Remove	Continue	Remove	Remove	Remove	Remove	Remove	Continue	Remove	Remove	Remove	Remove	Remove	Continue	Remove	Remove	Remove	Remove	Remove

Figure 42. Third iteration of Pugh Matrix.

The five winning concepts selected for evaluation in the Kesselring matrix were C52, C63, C115, C133, and C215. Selection was based primarily on total sum scores across the three iterations, but with an additional consideration for variation across the concept pool. In cases where two or more concepts with identical scores belonged to the same configuration cluster, only one was carried forward to improve the variation. This ensured that the five concepts entering the Kesselring matrix represent distinct cab layout configurations. C52 and C63 represent the convertible rear bed cluster with extra storage module, C115 and C133 represent the foldable rear bed cluster with extra storage module, and C215 represents the passenger-side foldable bed cluster, preserving variation across all three bed configuration groups for the final weighted evaluation.

7.3 Kesselring Matrix

Following the Pugh Matrix analysis, which narrowed the field to five remaining concepts, these concepts were subsequently evaluated using a Kesselring matrix. Prior to the evaluation, a set of assessment criteria was established, see table 10.

Table 10. Criteria used in the Kesselring matrix.

Criteria	Description
A - Accessibility	The accessibility of the combined sub-solutions in the cab layout
B - Complexity of Construction	The complexity of the combination of sub-solutions featured in the concept layout
C - User Value	The value the concept's layout will bring the user based on the customer needs
D - Ergonomic Usability	The usability of the concept layout for members of the target group in the F05-M95 range
E - Spatial Efficiency	The use of space in the concept layout
F- Safety	Safety of the mounting, use cases and crash resistance of sub-solutions

The criteria were derived from the requirement specification, the identified user needs, and input from the Ergonomics Team. They were then incorporated into a pairwise comparison matrix, in which the criteria were ranked in descending order of importance as follows: user value, accessibility, ergonomic usability, safety, spatial efficiency, and complexity of construction (see Figure 43). Each criterion was assigned a weighted value w, where a higher value indicates greater importance. The criteria considered most critical to fulfil are C (User Value), A (Accessibility), D (Ergonomic Usability), and F (Safety).

Criteria	A	B	C	D	E	F	Sum	w
A	-	1	0	0.5	1	0.5	3	0.214
B	0	-	0	0	0.5	0	0.5	0.036
C	1	1	-	1	1	0.5	4.5	0.321
D	0.5	1	0	-	0.5	0.5	2.5	0.179
E	0	0.5	0	0.5	-	0	1	0.071
F	0.5	1	0.5	0.5	1	-	2.5	0.179
Total							14	1

Figure 43. Pairwise comparison of criteria used in the Kesselring Matrix.

The scoring applied in the pairwise comparison was based on the rationale from previous evaluations as well as the developed personas. Following the calculation of weighted factors from the pairwise comparison, each concept configuration was assessed against the defined criteria. For instance, with regard to accessibility, the combination of a standard refrigerator with a convertible bed was identified as the least favorable configuration, receiving a score of 1. These evaluations are presented in Figure 44, representing the value *v* in the Kesselring Matrix.

A - Accessibility		B - Complexity of Construction		C - User Value	
Combination	Value (v)	Combination	Value (v)	Combination	Value (v)
Standard Fridge + Convertible bed	1	Extendable table + convertible bed + dashboard fridge	1	Foldable table + foldable bed side	2
Dashboard Fridge + Convertible bed	2	Extendable table + foldable bed rear + dashboard fridge	2	Extendable table + foldable bed rear	3
Dashboard Fridge + Foldable bed side	3	Extendable table + foldable bed rear + standard fridge	3	Foldable table + convertible bed	4
Standard Fridge + Foldable bed rear	4	Foldable Table + Foldable bed side + Dashboard fridge	4	Extendable table + convertible bed	5
Dashboard Fridge + Foldable bed side	5	Foldable table + convertible bed + standard fridge	5		
D - Ergonomic Usability		**E - Spatial Efficiency**		**F - Safety**	
Combination	Value (v)	Combination	Value (v)	Combination	Value (v)
Extendable table + convertible bed	2	Extra storage module + standard fridge	3	Foldable bed + foldable table	2
Foldable table + convertible bed	3	Extra storage module + dashboard fridge	5	Foldable bed + extendable table	3
Foldable table + foldable bed side	4			Convertible bed + foldable table	4
Extendable table + foldable bed rear	5			Convertible bed + extendable table	5

Figure 44. Weighting of criteria used in the Kesselring Matrix.

The weighted factors and the scores assigned to each configuration were entered into the Kesselring matrix. An ideal concept, representing the optimal values across all criteria, was also included for the concepts to be weighed against. The weighted factor *w* was subsequently multiplied by the corresponding value *v* to yield a weighted value *t* for each criterion, see the following equation:

$$t = w * v$$

An ideal concept was first evaluated by assigning the maximum score of 5 to all values *v*. Once all weighted values *t* had been calculated, they were summed to produce a total score $T\ (\sum t)$ for each concept, including the ideal. The total values were used to rank the concepts, enabling the selection of the concepts to be further development. The Kesselring matrix can be seen in Figure 45 below.

Kesselring Matrix													
Concepts		Ideal		Concept 52		Concept 63		Concept 115		Concept 133		Concept 215	
Criteria	w	v	t	v	t	v	t	v	t	v	t	v	t
A - Accessibility	0.214	5	1.07	2	0.428	1	0.214	5	1.07	4	0.856	3	0.642
B - Complexity of Construction	0.036	5	0.18	1	0.036	5	0.18	2	0.072	3	0.108	4	0.144
C - User Value	0.321	5	1.605	5	1.605	4	1.284	3	0.963	3	0.963	2	0.642
D - Ergonomic Usability	0.179	5	0.895	2	0.358	3	0.537	5	0.895	5	0.895	4	0.716
E - Spatial Efficiency	0.071	5	0.355	5	0.355	3	0.213	5	0.355	3	0.213	5	0.355
F - Safety	0.179	5	0.895	5	0.895	4	0.716	3	0.537	3	0.537	2	0.358
$T = \sum t_i$		30	5	20	3.677	20	3.144	23	3.892	21	3.572	20	2.857
T / T_{max}		1	1	0.667	0.7354	0.667	0.6288	0.767	0.7784	0.7	0.7144	0.667	0.5714
Ranking				3		3		1		2		3	
Decision				Continue				Continue				Continue	

Figure 45. Results from the Kesselring Matrix.

Concepts 52, 115 and 215 were ultimately selected for further development through the evaluation process. Through the evaluation process, Concept 52 and Concept 115 achieved the highest scores, with the primary distinguishing factor between them being the sleep and resting configuration. A third concept, Concept 215, was selected in order to maintain variation among the chosen concepts, given the close similarities observed between Concepts 52 and 63, as well as between Concepts 115 and 133.

7.4 Concept Selection

The Concept Selection was performed in an evaluation session held together with the CAB Ergonomics team where Pros and Cons of the three remaining concepts were identified and listed. The evaluation consisted of a walkthrough of the three remaining concepts, detailing the different sub-solutions included in the cab layout as well as different variations to give the team a better understanding of the thought process behind each concept. The Pros and Cons evaluation produced a comprehensive set of strengths and weaknesses for each of the three concepts, compiled in Figure 46. The session resulted in the unanimous elimination of Concept 115 and 215, as well as the continued development of Concept 52.

Concept 52		Concept 115		Concept 215	
Pros (+)	Cons (-)	Pros (+)	Cons (-)	Pros (+)	Cons (-)
Wider bunk when needed, folds away when not in use	Bed mechanisms may obstruct or cover the passenger door	Multiple seating options when the bunk is in sofa mode	Loose parts in the bed configuration, sectioned mattress has been tried before and is not appreciated by drivers	Provides a longer sleeping surface, better for tall drivers	Passenger-side bed does not provide psychological separation between driving and living space
Possibility to lie down in lounge mode for added resting comfort	Requires a specially shaped or split mattress, which may be uncomfortable	Enables eating at a real table with a genuine dining setup	Creates uncomfortable partitions in the sleeping surface	Represents a distinctive way to differentiate Volvo from competitors	Covers or obstructs the passenger door, significant safety issue in the event of rollover
Vertical split position near the shoulder rather than the hips, reducing discomfort when sleeping	Reduced storage under the bed	Opportunity to host two people, good for social eating with a colleague	Storage under the bed disappears entirely	Acceptable configuration in the context of the confidential electric truck platform	Does not comply with a new legal demand for seating arrangement position
Additional space on the passenger side when bed is stowed	Access to rear controls and charging outlets may be compromised	Good for creating a social space distinct from the driving position	Reduced overall storage space compared to current cab	Offers additional storage volume on the non-bed side	Mattress partitions where sections meet are uncomfortable
Increased bunk width compared to current offering	Back support limited when a small portion of the cushion is folded up	Table options possible while resting, adding flexibility	Comfort when sleeping may be compromised by the split mattress	More walkthrough clearance when the bed is stowed	Proximity to the passenger window results in cold exposure, poor thermal insulation from the glass
Could function as a passenger-side sofa configuration	Shape of mattress may deform over years of use	Similar in principle to Volvo VNL cab layout (whole bed lifting)	High complexity of construction		May block the side window and reduce natural light
Lower complexity compared to C115, fewer steps to convert	Less walking space and restricted seat travel inside the cab when the bed is open	Swivelling driver seat and pull-out dashboard table could supplement this concept	Adapted primarily for multiple occupants, may not reflect the single-driver target group		Visibility to the passenger-side window is restricted
			Less opportunity to lie down compared to C52		Difficult to exit if parked on a slope
			Missing middle storage may only be acceptable if replaced by a center seat		Only space for the driver seat and sleeping bunk, minimal lounge area

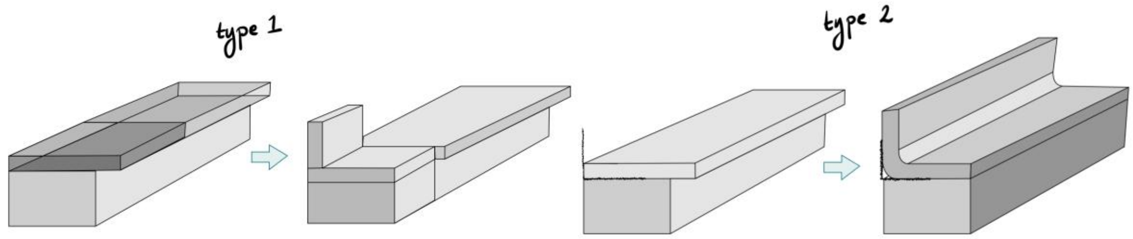
Figure 46. Pros and Cons list of remaining concepts.

8 Concept Finalization

For the concept finalization phase, the different versions for the sub-solutions featured in concept 52 were evaluated and finalized before modelling them in Catia, choosing materials and performing ergonomic evaluation.

8.1 Evaluation of Sub-Solutions

Three main types of convertible beds were considered. They were each evaluated based on the perceived complexity while in use as well as accessibility and comfort for users in the F05-M95 range. After considering the mechanisms that would be required for Type 1 and 2, as illustrated in Figure 47 below, they were deemed to be either too complex or cause discomfort due to the positioning of the folds. The positioning of the folds and "split-line" of the mattress was evaluated in person by the thesis workers to find an optimal ratio that would lead to the highest level of comfort for the users in the defined target range. As such, Type 3 was the version used in the final concept which featured a set of guiding rails to move it along, an easily accessed button similar to the way current truck bunks are folded up which unlocks the bed allowing it to be converted into its bed-sofa like structure. The chosen solution allows the user to convert the bed in a single continuous motion, directly responding to the customer need for simplicity and minimal setup time, as the conversion requires no tools, and no repositioning of loose components.



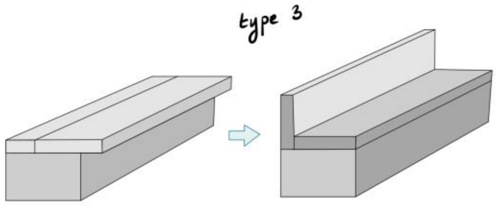


Figure 47: The three convertible bed configuration type 1, 2 and 3 respectively.

The final version of the convertible bed configuration, type 3, along with the steps required to manoeuvre it are shown in Figure 48 below. When modelling the convertible bed, similar measurements to the existing bed configuration were used but a mattress with slightly smaller thickness was modelled. This modification serves two ergonomic purposes by improving the mechanics of the fold transition and lowering the seated height of the bed-sofa to a more comfortable level for users in the lower end of the target range. The current bunk height was observed to be slightly too high for comfortable seated use, particularly for the F05 persona, where the existing configuration results in unsupported leg hang and increased lumbar load. The converted bed-sofa was also designed to provide a seat depth comparable to a standard residential sofa, ensuring that users can sit with adequate thigh support and a natural backrest angle rather than perching on the edge of a sleeping surface.

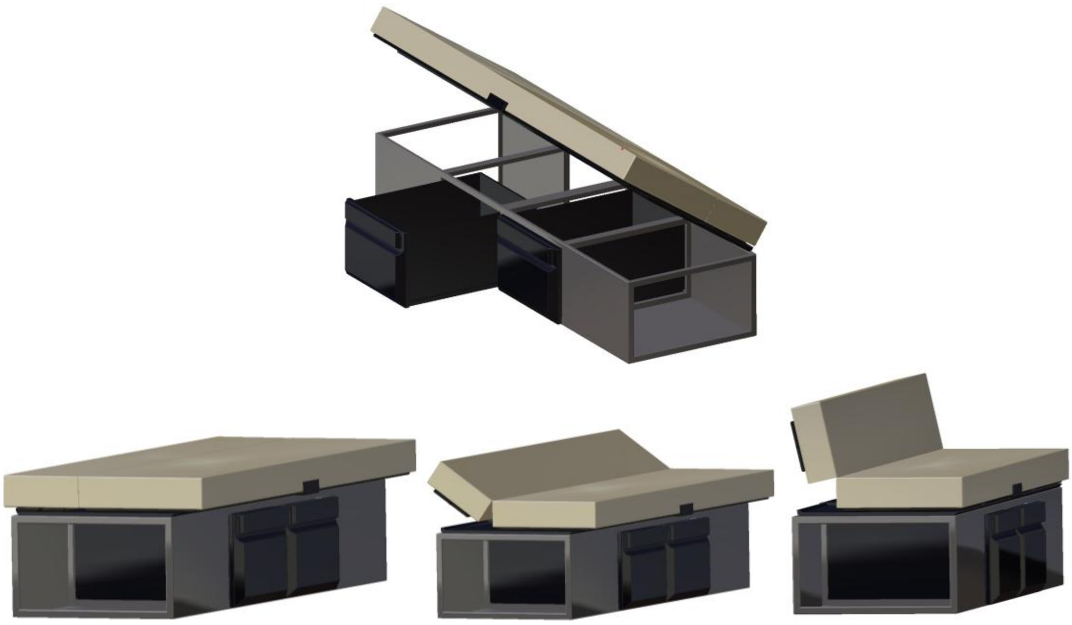


Figure 48. Final version of a convertible bed configuration.

The foldable seating group function was included in the convertible bed configuration. The first drafts for the configuration featured a foldable seat located in the dashboard, but issues regarding visibility and ergonomics made this option unfeasible. The Type A forward-facing dashboard seat would place the user in proximity to the dashboard cluster and would not allow the driver to face a table surface in a comfortable posture. In addition, the seat would have difficulty integrating a table into the dashboard in a convenient manner. For the convertible bed configuration Type 1, the foldable seat was located on the side of the bed as showcased in Type b, but as mentioned above, the positioning of the fold disqualified that concept due to an uncomfortable split in the mattress when laying down. This led to the final concept of a foldable seating group in the form of a sofa, allowing the full width of the bunk to serve as a seated surface with a continuous and supportive base. The three concepts can be seen in figure 49.

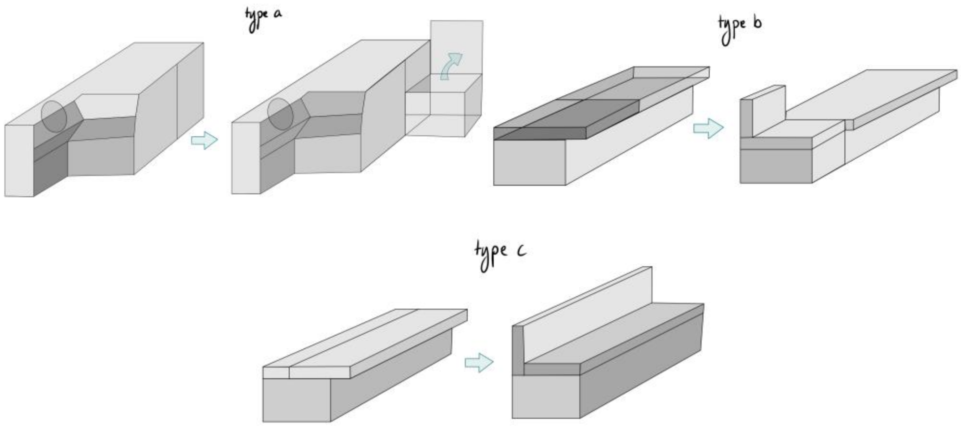


Figure 49. The three different seating group configurations, type a, b and c

Regarding the dashboard fridge and adapted dashboard for meal preparation, different fridge configurations were explored as part of the dashboard sub-solution. The dashboard itself underwent a comprehensive redesign, taking into account the customer needs and preferences identified through the user study, particularly those relating to the availability of a flat, usable surface for meal preparation. The initial proposal involved integrating a single large refrigerator directly adjacent to the driver's position within the dashboard. However, this configuration was ultimately deemed unfeasible due to constraints imposed by the existing cab architecture, as illustrated in Figure 50.

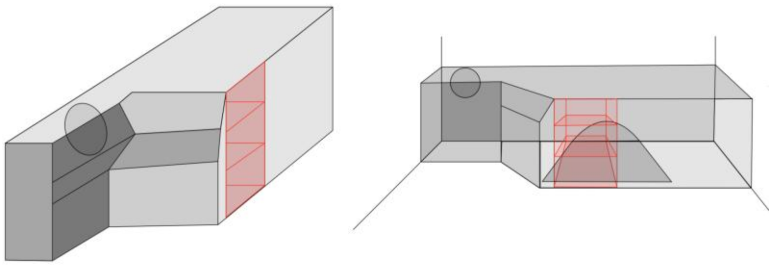


Figure 50. Illustration of positioning a large refrigerator near the driver’s position

Consequently, the dashboard refrigerator concept was revised and reconfigured into a dual-refrigerator solution. The first unit consists of a smaller refrigerator positioned within easy reach of the driver, intended for the storage of smaller items such as sandwiches and beverages. Its placement directly addresses a specific ergonomic risk identified in the interviews. In the current Volvo FH configuration, the passenger-side fridge requires the driver to reach diagonally across the cab, taking their eyes off the road and introducing an unnecessary safety risk. A driver-adjacent mini-fridge eliminates this reach conflict and complies with requirements for usability when driving without compromising safety. The second unit is a larger refrigerator located on the passenger side of the dashboard directly responding to the customer need for increased cold storage capacity, replacing the refrigerator currently positioned beneath the bed in the standard cab configuration. This repositioning enables the integration of a full-standing refrigerator with a significantly greater storage capacity, allowing for improved accommodation of lunchboxes and food items compared to the existing solution, as illustrated in Figure 51.

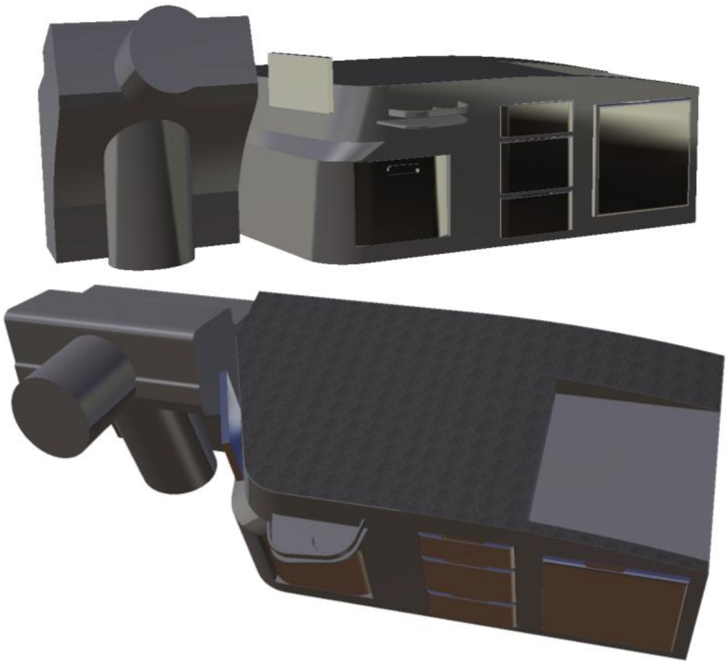


Figure 51. Dashboard with a minifridge by the driver's seat and a larger fridge to the right.

An extra storage module was created and placed near the bed, enabling space for an extendable table to use while eating, as shown in Figure 52 below. The module housed a microwave, but a coffee brewer could also have been placed inside. Additionally, the module contained three drawers, allowing storage for the user's personal items. The storage module configuration is adaptible but the current design was based on the customer need of having a stationary table and simplicity of use. The microwave in the storage module is placed at a much more easily accessible height than its current placement in the storage compartment over the passenger's head. The new placement of the microwave is at a more convenient height than the old one, reducing the need for shorter users to raise their arms and shoulders above their heads to use it. The drawers and extendable table were modelled to be easily accessible for the driver when seated on the bed, taking ergonomics and existing requirements into account. The drawers were modelled at a height consistent with the existing under-bed storage drawers, ensuring that the interaction is familiar and does not introduce new reach demands. The extendable table was positioned at a height derived from standard dining table ergonomics relative to the bed-sofa seated height, ensuring that users can eat with their forearms supported at a natural angle without raising or lowering their shoulders. This directly addresses the requirement that drawers must be operable without hindrance, and responds to the customer need for a stable, flat eating surface at a comfortable height. The module configuration is adaptable, but the current design was anchored in the customer need for simplicity of use. The interactions for the storage module were designed to be completable in a single motion where possible, with no loose components requiring separate stowage.

Figure 52. Storage module with an integrated extendable table.

8.2 CAD-modelling

The CAD-modelling began with creating a platform from reference truck models, on which the components were placed upon. The full layout of the cab was created using a mix of generative surface modelling and part design. The cab layout was modelled in different segments which were then imported and combined into a product which contained all sub-solutions, the model can be seen in Figure 53 below. An example of the bed conversion is also showcased in figure 54.

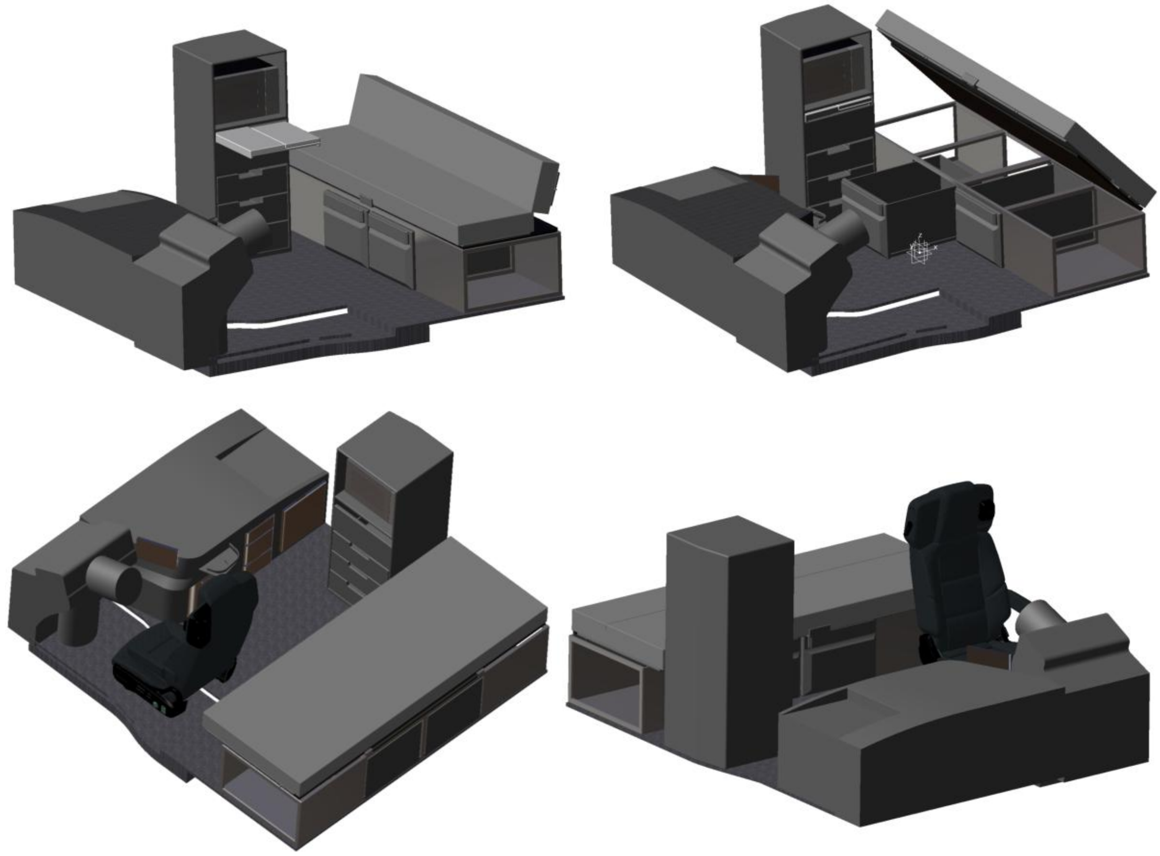


Figure 53. Final concept model in CATIA v5.

Figure 54. Sideview of cab showcasing bed-to-sofa conversion.

8.3 Material Selection

Material selection for the final concept was guided by Volvo Trucks' internal sustainability ambitions and the emerging regulatory landscape for vehicle circularity. The approach prioritizes carbon neutrality, cradle-to-gate lifecycle thinking, and a high level of material circularity to ensure that proper end-of-life handling remains possible. Volvo Trucks' material usage guidelines for both interior and exterior truck cab components were followed and taken into consideration throughout the selection process.

In line with Volvo's guidelines, the material choices were further governed by the proposed Regulation 2023/0284(COD) on circularity requirements for vehicle design and the management of end-of-life vehicles, for which a provisional agreement was reached by the European Parliament and Council in December 2025. The regulation requires that new vehicle plastics contain at least 15% recycled content within six years of the rules taking effect, and 25% recycled content within ten years (European Parliament, 2025). The material families selected for the concept components are therefore oriented toward fulfilling these thresholds

Due to strict confidentiality requirements governing Volvo Trucks' interior specifications, the specific polymer types and alloy grades used in production cannot be disclosed. The materials listed in Table 11 are therefore expressed as generic material families rather than proprietary compound specifications, while remaining consistent with the recycled content and performance requirements applicable to each component. Components that were not able to be influenced by the thesis project such as the refrigerator, microwave and other appliances were omitted from the material selection.

Table 11. Materials for components of the cab layout.

Component	Material Choice
Bed frame	Recycled aluminium or carbon neutral steel
Drawers	Recycled polymer (medium density)
Bed plates	Recycled polymer (high density)
Storage unit	Glass fiber reinforced polymer
Dashboard surface	Recycled Vinyl
Dashboard structure	Glass fiber reinforced Polymer
Floor	Glass fiber reinforced Polymer

8.4 Ergonomic Evaluations

Ergonomic evaluations of the final concepts were performed using digital human manikins in DS DELMIA (CATIA v5) and a semantic scale after experiencing the concept in a VR environment.

8.4.1 Ergonomic Evaluations in CATIA v5

In DS DELMIA, digital human manikins were imported, and the Rapid Upper Limb Assessment (RULA) scoring method was applied (McAtamney & Corlett, 1993). The manikins were imported into the assembled cab concept in Catia V5 using the Human Builder Workbench. Three manikins were used with anthropometry corresponding to the personas by using manikins of the defined F05, M50, and M95 sizes (Högskolan i Skövde, n.d.).

The manikin data was used to evaluate the bed-to-sofa transition mechanism, the extending table solution, and the general sense of spatial scale with a person sitting in the cab environment. The manikins and their body parts were adjusted manually limb by limb, leading to a decent level of posture simulation. Being able to visualize the cab interior with anthropometrically correct manikins allowed for a better perception of the space in the cab for different sized people, see figure 55. Other sub-solutions related to dashboard usage and storage drawers were not evaluated using manikins, as these interactions are present in similar forms in existing production trucks and do not represent novel ergonomic scenarios introduced by the concept.

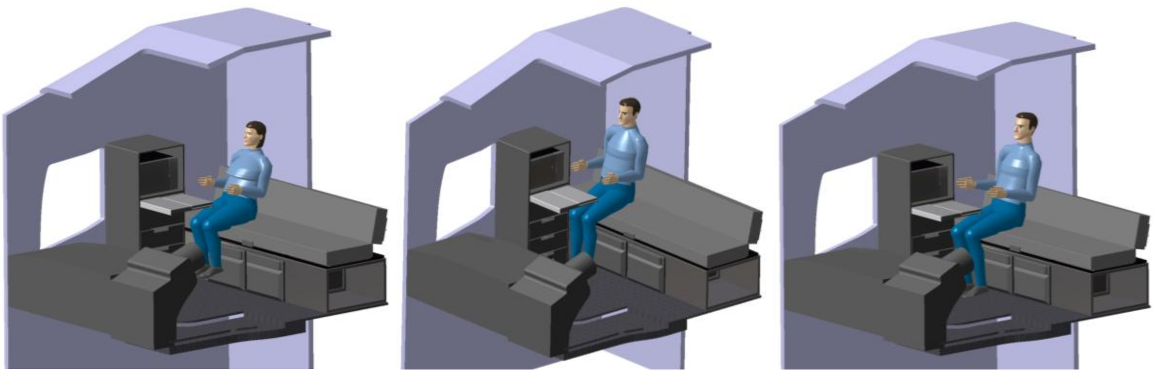


Figure 55. Size comparison of F05, M50 and M95 sized manikins sitting on the convertible bed.

The RULA scoring method assesses upper limb posture risk on a scale of 1 to 7 by examining a combination of factors including number of movements, static muscle work, applied force, working posture, and time worked without a break (Dassault Systèmes, n.d.).

- Scores of 1–2 indicate that the posture is acceptable if not maintained or repeated for long periods.
- Scores of 3–4 indicate that further investigation is needed and changes may be required.
- Scores of 5–6 indicate that investigation and changes are required soon.
- Score of 7 indicates that investigation and changes are required immediately

The RULA analysis of the start position of the bed to sofa conversion is showcased in figure 56, and the end position of the bed conversion is shown in figure 57. The results of the RULA analysis including all three anthropometric manikins for the bed conversion mechanism are shown in Table 12.

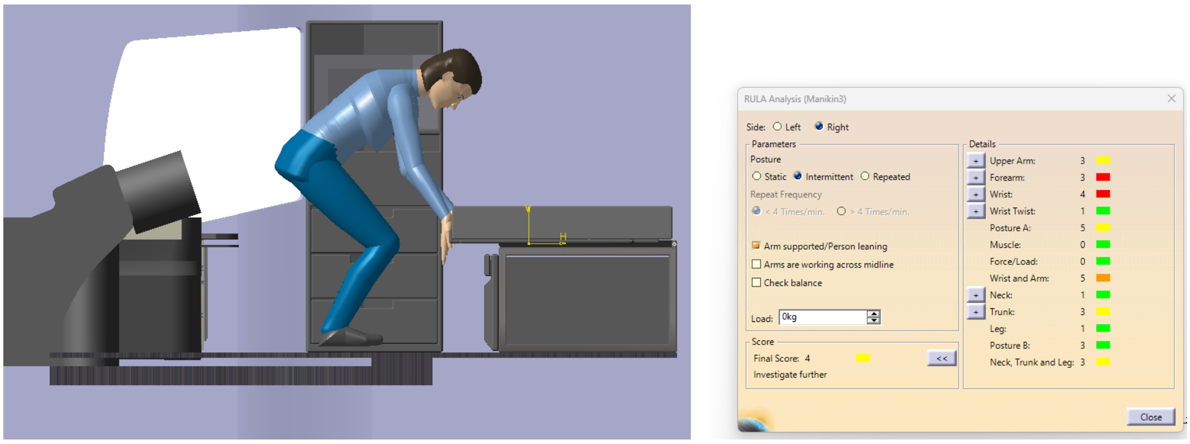


Figure 56. RULA analysis of start position of bed conversion.

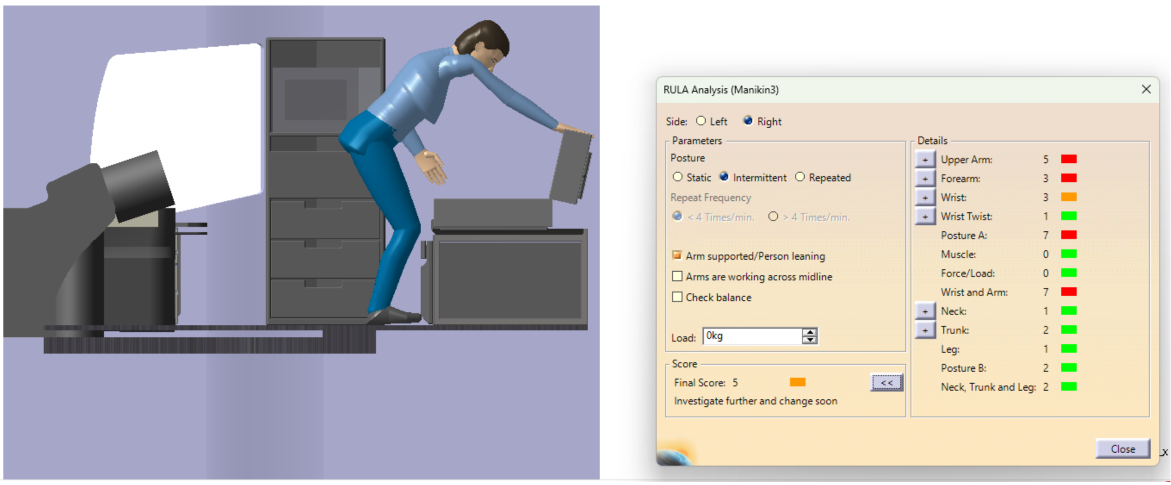


Figure 57. RULA analysis of end position of bed conversion for F05.

Table 12. RULA Analysis scores

Percentile	Start position	End position
F05	4	5
M50	3	4
M95	3	3

The scores of the RULA analysis indicate that improvements to the conversion mechanism are needed, particularly for the F05 user, whose end position score of 5 places the movement in the category requiring investigation and change in the near term. The M50 end position score of 4 falls at the boundary of the same category, indicating that refinement of the motion sequence would benefit users across the anthropometric range. The M95 configuration scores 3 in both positions, which is within the range requiring further investigation but does not trigger an immediate requirement for change.

It should be noted that manikins in DELMIA are difficult to position in fully natural ways, which may affect the RULA scores both positively and negatively. The scores should therefore be interpreted as a directional indication of ergonomic risk rather than a precise measurement. The evaluation was nonetheless valuable as a concrete means of observing the posture demands of the conversion mechanism and identifying where the motion sequence places the most demand on the upper limbs.

The evaluation is further contextualized through the framework provided by Ulrich and Eppinger (2012) who describe a set of five questions to identify the ergonomic needs of a product.

How important is ease of use?
Throughout the thesis the ease of use has been a priority directly supported by the interview data, where simplicity was the only customer need to reach all ten participants. It is further reflected in the ergonomic findings that the conversion mechanism must be operable without excessive physical effort across the full anthropometric range. To be a feasible implementation at all the conversion should either be fully electrical or be possible to perform where the current handle to lift the bed is located.

How important is ease of maintenance?
Ease of maintenance is similarly important, as all surfaces and moving parts must be cleanable and serviceable within the cab environment. The components were all designed to place no greater demands on body posture or physical effort than existing configurations by Volvo. The new bed solution will require periodic inspection and cleaning to prevent debris accumulation that could impair the sliding motion. However, the rail system is positioned along the vertical edges of the bunk and is not meaningfully more demanding than accessing the existing bunk latch mechanisms to raise the bed in today's trucks. It should nonetheless be noted that this aspect of the concept has not yet been evaluated with a physical prototype, and a more definitive assessment of maintenance ergonomics would require hands-on user testing as part of a subsequent detailed design phase.

How many interactions are required for the product's function?
The number of interactions required for the conversion between bed and sofa mode was a deliberate design consideration which focused on keeping the mechanism as simple and easy to understand as possible. Although precise mechanisms have been omitted from the concept, only one motion is required in combination with releasing a button-controlled latch to convert the bed into a sofa and vice-versa. The RULA analysis could not provide insight into any aspects relating to cognitive ergonomics or time-related use but was used to evaluate the extreme positions related to reach. Through the RULA analysis it was deemed that the F05 user had a hard time reaching the top of the folded up bed. This revelation led to the conclusion explained in the ease of use section above.

How novel are the user interaction needs?

Regarding novelty of interaction, while bed-to-sofa conversion mechanisms exist in home furniture and recreational vehicles, no equivalent solution was identified in any production truck cab in the competitor vehicle analysis, confirming that the conversion mechanism represents a novel interaction in this product context.

What are the safety issues?
Safety requirements mandate that all sub-solutions must remain secure during cab tilting operations and satisfy criteria relating to different crash scenarios defined in the requirement specification, ensuring that no component becomes a hazard in the event of a collision. Due to the conceptual nature of the cab layout concept, safety has not been fully explored.

8.4.2 Ergonomic Evaluations in Virtual Reality

In addition to the RULA analysis in Catia, an ergonomic assessment was performed using a VR (Virtual Reality) setup of the cab layout where the components could be evaluated in-person yielding more accurate results. The VR setup was created using Autodesk VRED Pro (Autodesk, 2024) by importing the CAD Product file from Catia V5. By using location markers and a driver seat mock-up the cab was able to be displayed in full realistic scale leading to a more qualitative experience of the concept and its different components. In the ergonomic assessment performed in the VR environment, six experts including members of the CAB Ergonomics team got the opportunity to interact with the cab layout and features to more accurately evaluate the ergonomics, see figure 58.

Figure 58. Expert evaluating ergonomic aspects of the cab concept in the VR environment.

The VR session contained elements of truck cab interiors that cannot be disclosed due confidentiality. Parts of the cab interior have therefore been replaced or adjusted in post. The adjusted images of the cab concept integrated into the VR environment can be seen in figure 59.

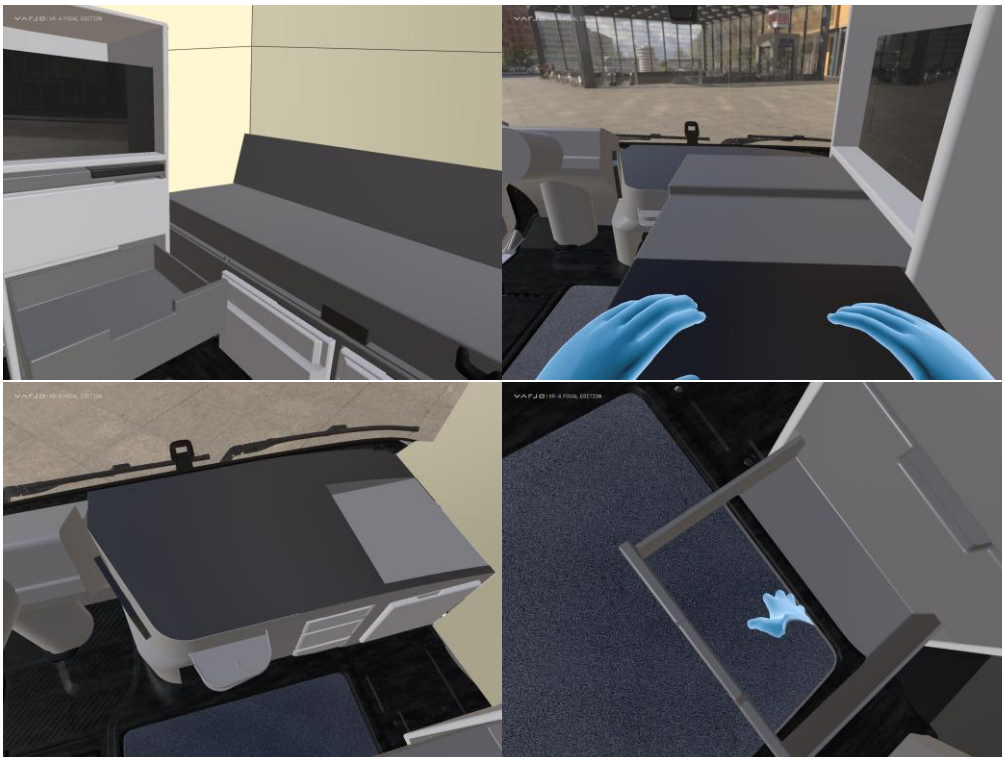


Figure 59. Cab concept displayed in the VR environment.

As part of the ergonomic evaluation of the concept a semantic scale adapted from Ulrich and Eppinger (2012) was used to rank aspects of the concept on a scale from 1 to 7. A low score is placed between 1-2, medium between 3-5, and high between 6-7. The mean score of the six participants' results is showcased in figure 60.

<table>
<tr><th>Needs</th><th colspan="3">Ranking</th><th>Score</th><th>Explanation of rating</th></tr>
<tr><td></td><td>Low</td><td>Medium</td><td>High</td><td></td><td></td></tr>
<tr><td>Ease of use</td><td colspan="3">|--------------------------------X-----------------|</td><td>5</td><td>Is the concept ergonomically accessible</td></tr>
<tr><td>Ease of reach</td><td colspan="3">|-----------------X--------------------------------|</td><td>4</td><td>Are sub-functions of the concept easy to reach</td></tr>
<tr><td>Quantity of user interactions (bed conversion)</td><td colspan="3">|--X---------|</td><td>6</td><td rowspan="3">How many user interactions are required to use parts of the concept</td></tr>
<tr><td>Quantity of user interactions (dashboard)</td><td colspan="3">|-------------------------X------------------------|</td><td>4</td></tr>
<tr><td>Quantity of user interactions (storage module)</td><td colspan="3">|-------------------------X------------------------|</td><td>4</td></tr>
<tr><td>Novelty of user interactions</td><td colspan="3">|---------------------------------X-----------------|</td><td>5</td><td>How novel is the user interaction compared to existing solutions</td></tr>
<tr><td>Safety</td><td colspan="3">|---------------------------------X-----------------|</td><td>5</td><td>Safety of the concept</td></tr>
<tr><td>Usability of the concept</td><td colspan="3">|---------------------------------X-----------------|</td><td>5</td><td>How easy is the concept to use</td></tr>
<tr><td>Product differentiation</td><td colspan="3">|---X--------|</td><td>6</td><td>Is the concept different to existing solutions on the market</td></tr>
<tr><td>Team motivation</td><td colspan="3">|---X--------|</td><td>6</td><td>How motivating is the concept for the team to continue development</td></tr>
</table>

Figure 60. Results of the semantic scale during ergonomic evaluation.

In addition to the mean score, comments made by the experts during the evaluation were compiled in figure 61.

Needs	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6
Ease of use	Drawer in dashboard quite low, difficult to access in standing position. Roof shelf might hit the head when accessing items placed on the dashboard.	Bed height enabled a good seating position for the legs and still had clearance between knee and table.	Cupboard ok, but dashboard is too limited, too low. Standing fridge would be quite hidden.	–	–	Too many functions. Things are in the way when bending down. Too narrow between fridge and module to access fridge.
Ease of reach	–	Cupboard was accessible from the bed. Fridge slightly hard to reach. Top lid concept was great.	–	Only cupholder and low dashboard reachable without difficulty.	Cupholder is difficult to reach. Might hit head if you bend down to reach for cupholder. Not good to avert attention from road	Good reach to table and microwave. Lowest drawer should be removed it's like reaching the floor. Not easy to reach items in fridge. Pull out like a drawer instead of door on hinges.
Quantity of user interactions — bed	Good idea to push the bed up to improve on space.	–	–	–	–	Good if unlocked and pulled out/pushed in one motion from the front edge under the bunk.
Quantity of user interactions — dashboard	Roof shelf might hit the head when accessing items placed on the dashboard.	–	Many interactions and high risk for hitting the head on the front shelf.	–	–	Fridge door opening and then accessing items. Use a drawer concept instead.
Quantity of user interactions — storage module	Storage-wise good. Accessibility medium for reach.	–	Many functions and storage, easy to reach and use.	–	–	Many interactions for table folding and too many storage drawers.
Novelty of user interactions	–	Bed folding into sofa instead of hospital bed-like motion was newer.	–	–	–	Similar to existing solutions in trucks and homes.
Safety	–	Does removing or compromising access to the passenger door increase risk of tipping accidents?	Risk for hitting the head on the front shelf or on the corner of the storage module. Small gap between storage and front shelf.	Only problem identified is the cupholder.	–	Good without open storage surfaces. Storages and drawers need to be locked in place in case of crash.
Usability of the concept	–	Comparing to a two-seat configuration, there is a lot of living space.	–	–	–	Good start but needs more user studies and physical testing to improve access and space for using it. Has high potential!
Product differentiation	Unique.	Very different to what I've seen.	Only comparable to US manufacturing — nothing similar in EU.	–	–	Could be really different for European market trucks. Similar solutions exist in North American trucks.
Team motivation	–	Not sure about regulations regarding removing the passenger door and seat, but it seems efficient.	Many opportunities! Needs more fine tuning but could be a good addition to the product lineup.	–	–	Can be a USP for Volvo in the European focused cab for a single driver. Very good sofa bed concept. Really creates more space in the cab!

Figure 61. Expert comments from ergonomic evaluation

From the comments and subjective ratings through the semantic scale, the results indicate that there are several areas of the concept in need of improvement. Reachability of the bottom drawers featured in the storage module and dashboard was poor and required the driver to either sit on the bed or stand bent over in an uncomfortable position to pull them out. The dashboard height was deemed too low and too deep to comfortably store and retrieve items while standing. There was also an issue of collision with the storage unit above the driver's head while reaching down to reach the fridge, drawers and reach the far end of the dashboard. Additionally, the shape of the storage module could be improved to better account for appliances and reduce the visual blockage caused by the module as it extends past the current passenger side window. Another valuable insight was to better utilize the dead space between the dashboard and storage module by extending either of the components to connect with one another. While the VR Assessment led to a series of valid critiques on the concept through the ergonomic evaluations, it also showed that there was room for concrete improvements that could enhance the concept.

8.5 Requirement Fulfillment

An evaluation of the requirement specification that was followed in the thesis work shows that the majority of the established requirements have been met. A summary overview is presented in Figure 62 below.

Requirement specification						
	Criteria	Specified value	Type of Requirement	Verification Method	Justification	Fulfilment
	Function(s)					Yes / No / Not explored
1	Resting comfort					
1.1	Sleeping height with adjustable top bunk in lowermost position	Confidential	Living	CAD Evaluation	Volvo	Not explored
1.2	Mattress width	Confidential	Living	CAD Evaluation	Volvo	Yes
1.3	Easily cleanable interior	Generic	Living	Material Selection	Volvo	Not explored
1.4	Access underbunk storage while sitting on the bunk	Generic	Living	VR-evaluation	Volvo	Yes
1.5	Enough space to walk through the cabin	Generic	Living	VR-evaluation	Volvo	Yes
2	Cab construction					
2.1	Luggage lid closing force	Confidential	Technical	CAD Evaluation	Volvo	Not explored
2.2	Rear wall panel storage, weight of stored items	Confidential	Technical	CAD Evaluation	Volvo	Not explored
2.3	Passenger seat shall fold to flat (or atleast be perceived as flat)	Generic	Living	CAD Evaluation	Volvo	Not explored
2.4	Rear wall storage	Generic	Living	CAD Evaluation	Volvo	Not explored
2.5	Access exterior storage compartments from inside cab	Generic	Living	Mock-up	Volvo	Yes
2.6	Cab dimensions	Confidential	Living	Concept Evaluation	Volvo	Yes
2.7	Solution must be secured when cab is tilted	Generic	Technical	Concept Evaluation	Volvo	Yes
2.8	Pull out drawers without hindrance or clashing with the user	Generic	Technical	CAD Evaluation	Volvo	Yes
2.9	Storage capacity interior	Confidential	Living	CAD Evaluation	Volvo	Yes
2.10	Storage capacity exterior	Confidential	Living	CAD Evaluation	Volvo	Yes
2.11	No sharp edges	Confidential	Safety	CAD Evaluation	Volvo	Yes
2.12	Account for integrated microwave	Generic	Safety	Concept Evaluation	Volvo	Yes
2.13	Account for integrated coffee machine/water kettle	Generic	Safety	Concept Evaluation	Volvo	Yes
2.14	Account for refrigerator drawer	Interior size of: 336W x 367D x 268H [mm]	Living	Concept Evaluation	Pre-study	Yes
2.15	Drawer handles under bunk	Minimum width: 95 mm Maximum depth: 50 mm	Technical	Anthropometric Evaluation	Pre-study	Yes
3	Ergonomics					
3.1	Simple and intuitive design	Clear symbols	Technical	Concept Evaluation	Pre-study	Yes
		Contrast colors (decern in the dark)	Technical	Ergonomic Evaluation	Pre-study	Yes
3.2	Usability during driving (F05 - M95)	Generic	Performance	Anthropometric Evaluation	Pre-study	Yes
3.3	Usability during standstill (F05 - M95)	Generic	Performance	Anthropometric Evaluation	Pre-study	Yes
4	Sustainability					
4.1	Amount of recycled plastics used - interior	Confidential	Technical	Material Selection	Volvo	Yes
4.2	Amount of recycled metals used - interior	Confidential	Technical	Material Selection	Volvo	Yes
5	Regulations					
5.1	Flammability requirements	Fulfill UN/ECE Regulation 118	Safety	Concept Evaluation	Regulation	Not explored
5.2	Electrical appliance safety	Fulfill EU 2014/30, EU 2014/35	Safety	Concept Evaluation	Regulation	Not explored
5.3	General Safety Regulation	Fulfill EU 2019/2144	Safety	Concept Evaluation	Regulation	Yes

Figure 62. Fulfillment of the requirement specification.

9 Discussion

This chapter presents a critical discussion of the outcomes and methodology of the project, with a focus on the validity, limitations, and implications of the results. Each subsection addresses a specific aspect of the development process, from the initial pre-study and user research through to concept generation, concept selection, the final proposed concept, and the main challenges that arose during the thesis.

9.1 Reflection on the Pre-Study

The pre-study was an important part of the thesis that laid foundation for the project. By implementing both qualitative and quantitative data from users, the study provided valuable insights into the user's perceptions regarding their well-being, both in terms of their eating habits and in general. It thus contributed to identifying key needs, wishes and obstacles, which served as the starting point for the concept development phase. Despite this, there are several aspects where the user study could have been improved.

As part of the pre-study, a company and market analysis was performed which gave insights into the long-haul truck market in Europe. The use of SWOT and PEST-EL deepened the understanding of Volvo Trucks as a company as well as its main competitors in the European market, but it ultimately served as background information. In hindsight, a more extensive market analysis, coupled with a more comprehensive benchmarking study, should have been performed to gain a better understanding of the competitors and their long-haul truck offerings rather than focusing on SWOT and PEST-EL. Despite a benchmarking study consisting of competitor long-haul trucks being performed, it was done at a time when the scope focused on identifying improvements to food-related items inside the cab more connected to kitchen features. If the benchmarking had been conducted with the adjusted scope, more standardized comparisons between trucks could have been performed which would yield better results to look back upon. A clear example of this was the revelation that several of the benchmarked trucks had a dashboard table which was completely overlooked in the study until after the accessory benchmarking and interviews were conducted.

The benchmarking analysis provided a valuable overview of the current market offering and helped establish a frame of reference for what cab interior solutions are available on the European market. The opportunity to examine competitor trucks in a physical context allowed a direct assessment of how specific components have been designed and integrated differently in different brands. Many models featured interesting solutions, while others clearly reflected the limitations of their price segment, with certain expected features absent in lower-tier configurations. One limitation of the benchmarking scope was that only a select number of models were accessible for physical inspection, which may have narrowed the understanding of certain solution spaces. It was also decided to exclude North American trucks from the benchmarking, despite their significantly larger cab volumes. Many North American long-haul cabs far exceed the dimensions allowed within Europe, offering amenities that are structurally out of scope for the chosen market. However, elements from the Volvo VNL model, the North American flagship model, were considered in the early stages of concept generation.

Identification of relevant legislation was difficult due to Volvo Trucks' own internal standards as they routinely develop proprietary specifications that exceed the minimum requirements set by external regulatory bodies. This made it difficult to determine the precise threshold to design against or to verify whether a proposed solution would satisfy Volvo's internal requirements. This made it more difficult to verify compliance with regulations as they were usually unable to provide the legislation corresponding to their internal requirements.

The patent search proved to be a valuable and complementary element of the pre-study. It provided insight into both futuristic design directions and older solutions that have either been adopted or abandoned in commercial truck development. Several of the identified patents addressed compact storage, foldable surfaces, integrated hygiene solutions, and novel bed configurations which served as help in the early stages of idea generation.

The literature review gave great early insights into the project background but ultimately proved to be partially inaccurate when it came to long-haul driver habits in Northern Europe based on the findings of the survey and interviews. While eating habits were identified in the literature as one of the primary factors to negatively affect the well-being of long-haul truck drivers, the results from the questionnaire only partially corroborated these findings, as the survey included all types of truck drivers, rather than exclusively long-haul drivers. This distinction proved significant, as the subsequent interviews contradicted these findings, revealing that eating and food-related habits were not perceived as a substantial obstacle in the manner that had initially been anticipated.

The questionnaire in itself was not without limitations. The questionnaire had low response rate in spite of the wide spread of the survey through various channels. One alternative would have been to use Volvo Trucks social media platforms, which could have had a higher likelihood of receiving answers, but the potential downside would have been the bias towards Volvo Trucks in comparison with competitor brands. The survey was also broadly designed with respect to general well-being, rather than specifically targeting eating habits, which may have reduced the precision of the data collected in relation to the study's primary focus. Furthermore, the questionnaire contained an excessive number of questions, which risks respondent fatigue and a subsequent decline in response quality. Additionally, inconsistencies in the rating scales used throughout the survey were identified, whereby the scale directionality varied across questions, which may have introduced confusion among participants and potentially compromised the reliability of the responses.

The interviews provided great insight into both the users' thoughts and their lifestyle. The goal was to conduct around 15 interviews. The results were however quite similar which resulted in only ten being performed. One notable limitation of the study concerns the geographical scope of the target group. The participant sample was predominantly composed of Swedish drivers, which may have resulted in a limited representation of long-haul drivers from other parts of Europe. Expanding the scope to include drivers from other European regions could have introduced greater variation in responses and provided a more comprehensive understanding of the problem space.

Regarding the drivers' attitudes towards cab design, it was observed that the interviewees found it difficult to envision an entirely redesigned cab environment, particularly given their general satisfaction with their current setup. No interviewed driver expressed a desire for complex food preparation solutions to be integrated into the cab. Instead, the findings suggest that simplicity is a key design principle, as any proposed changes should not introduce additional complexity beyond what already exists. However, should a feature offer a substantial improvement to the driver's quality of life, a degree of added complexity may be deemed acceptable. Latent and explicit needs that were consistently expressed across participants included access to running water and the availability of a dedicated lounge area within the cab.

9.2 Reflection on Concept Generation and Selection Process

The thesis began with a broad perspective on general well-being of truck drivers, which later was funneled down to the concept generation of layout concepts.

Although concept 52 was selected as the most suitable concept based on both systematic evaluation methods, user preferences and assessments with experts, it was reasonable to question whether any of the other concepts or concept categories would have been a more suitable option in a different context or with a different target group. Several of the concept categories and sub-categories, such as interface or food preparation solutions, that were eliminated displayed relevant strengths, for example in terms of user value, and may warrant further investigation in future studies. The decision to continue developing concepts within the interior category, specifically focusing on cab layouts, was made in dialogue with the CAB Ergonomics team at Volvo Trucks and was deemed the most appropriate direction given the scope and objectives of this project. While the other concept categories presented opportunities worthy of exploration, it was necessary to limit the scope of the work to a specific area in order to allow for sufficient depth in the concept development process.

Furthermore, based on the interview it became apparent that a dedicated kitchen solution was not aligned with the users' needs or preferences, which stood in contrast to the initial assumptions drawn from the literature review. Nevertheless, the results indicated that several food- and eating-related factors were of relevance to the users, including access to a larger refrigerator, a system for locating rest stops, and improved solutions for dish management. These findings highlight the importance of grounding concept development in empirical user data, rather than relying solely on theoretical assumptions.

9.3 Evaluation of Final Concept

Concept 52 incorporates several features that address the identified food- and eating-related needs of long-haul drivers. The inclusion of a standing, larger refrigerator provides increased storage capacity for lunchboxes and facilitates easy access to food items. A secondary minifridge positioned in proximity to the driver's seat allows for convenient access to smaller items such as sandwiches and beverages during the working day. Furthermore, the additional storage module with an extendable table, in combination with the convertible bed configuration, creates a dedicated lounge area physically separated from the driving environment. The new cab layout offers a functional and comfortable space for meals as well as additional storage for personal belongings, aligning with the identified needs and wishes from the pre-study. The final concept not only brings improvements to the eating space of the cab interior, but also to the drivers' resting comfort. By performing the extensive pre-study and interviewing long-haul drivers, the thesis took a turn from what was identified as problems from the literature and rather focused on problems which impacted the drivers in their daily lives.

However, the concept is not without limitations. The proposed design is an entirely new reconfiguration of the cab layout, involving the removal of the passenger seat and door, the introduction of a new dashboard, a convertible bed and seating area, and an integrated storage module with a foldable table. While these changes collectively address many of the needs and pain points identified through the user study, such an extensive redesign may conflict with the user's expressed preference for simplicity and ease of use in the beginning. Adapting to an entirely new cab layout and learning to operate its various components may present challenges during an initial transition period.

Additionally, it is worth noting that the partial solutions derived from the morphological matrix do not fully correspond to the final design outcome. This discrepancy can be attributed in part to the broad and interpretive nature of the sub-solution descriptions within the matrix, which allowed for considerable flexibility in how they were translated into the final concept. It is also important to note that the final concept only reached a conceptual layout level meaning it does not include machine elements, defined mechanical joints, or detailed moving part specifications. Components such as the bed conversion mechanism and the extendable table are represented as functional intentions rather than resolved mechanical designs. This means that several practical engineering questions, including how the conversion mechanism operates under load, how components lock into position, and how individual parts are manufactured and assembled, remain open and would require resolution in a subsequent detailed design phase.

An issue which was encountered in the modelling stage was the issue of creating the concept in Catia V5 on two separate computers with conflicting program versions which removed the ability to transfer products seamlessly from one computer to another. As the modelling stage began at such a late part of the project, it was decided to split the work up by components to later be assembled into one product. However, the version mismatch led to only one of the two computers having access to the full model, while the other computer contained a "mock-up" of the truck cab interior which was created to retain the correct dimensions. As a result, some of the modelled components were designed without the possibility to properly visualize the coherence of the cab layout, which became apparent in the ergonomic evaluations.

The ergonomic evaluation using the RULA analysis in DS DELMIA provided a useful insight into the ergonomic usability, but the method presented several practical limitations in this context. The manikins in DELMIA are difficult to position in fully natural ways, as their articulation does not replicate the fluid movement patterns of a real user. This made it challenging to simulate realistic body postures during the bed-to-sofa conversion, and the resulting postures used for scoring may not accurately reflect how a driver would perform the movement in practice. A further limitation was the difficulty in determining the usage frequency of the conversion mechanism, which is a parameter that directly influences the RULA score. Since the conversion is performed at most once or twice per day rather than repeatedly within a short timeframe, classifying it correctly within RULA's frequency categories was not straightforward.

The ergonomic evaluation performed in the VR environment aided in giving insight into the scale of the concept, highlighting the importance of taking a step back and looking at users in a real-world context to get an appreciation for the scale of certain components. This could have been performed by creating a mock-up or by simply using cardboard boxes with similar dimensions to quickly evaluate whether certain components would be in a comfortable use-range. Due to time constraints for creating the final concept in the CAD environment this was omitted but is something that should have been considered as it would have enabled more accurate scaling of parts such as the dashboard or storage module drawers. Despite the feedback on the usability of certain aspects of the concept, results from the ergonomic evaluation in the VR environment were acceptable based on the semantic scale. Additionally, the CAB Ergonomics team was excited by the new cab layout concept and appreciated the unique solution for a user-centered truck cab interior with a focus to improve driver well-being. The bed-sofa solution in particular was lifted as an innovative approach to an existing solution with high value, something that if further developed could be a great unique selling point for Volvo Trucks.

9.4 Challenges throughout the Thesis

Several challenges arose during the course of the thesis work that affected both the scope of the study and its final outcomes. Initially, the content of the thesis was broadened from its original focus on enhancing driver well-being in relation to dietary habits, to encompass factors that affect general well-being of long-haul drivers as well. This shift had implications for both the direction of the scope and the number of research questions the thesis aimed to address.

As a consequence of the expanded scope, the user study had to cover more areas than originally planned which led to the pre-study being far larger than participated. The questionnaire in particular caused delays in the product development process and yielded lower response rate than wanted. This, together with the broad nature of the questionnaire, made it difficult to draw conclusions and apply the data in a meaningful way, which in turn led to the increased importance of gaining valuable insights and information through the interviews.

Another unexpected turn came during the interview stage of the pre-study where the already adjusted scope came to be altered once more, as it was discovered that the literature and Volvo's original perception of their problems were not fully aligned with reality. This finding highlighted the importance of the pre-study and not only relying on existing literature which may be outdated or specific to certain geographical regions. Originally, the thesis focused on enhancing driver well-being through implementation or improvement of food-related support items, which was interpreted as improving their in-cab food-preparation abilities. It was however discovered that the cab's food-handling capabilities are more than sufficient and all of the interviewed drivers were satisfied with the current setup featured in their trucks. This led to a shift in focusing on a different identified user need, leading to the creation of a lounge-focused cab layout to primarily improve the driver's mental well-being by developing a space where there was a clear separation of the working environment from the resting area.

The subsequent delays throughout the project resulted in the final result being of conceptual character rather than including defined mechanical elements.

10 Conclusion

The research questions that were defined in the beginning of the thesis were answered to some extent. Based on the results of the pre-study the focus of the project shifted from developing food-related support features in the cab to creating a layout which enables drivers to properly relax and disconnect from the driving aspect of the work. The change in direction of the thesis not only altered the end-product but also lead to new revelations regarding truck-drivers and their well-being in Nordic countries. The change in direction led to RQ7 not being fully explored due to its close focus on the initial scope of the thesis.

RQ 1. How do truck drivers perceive the impact of their daily work on their well-being?
The results from the pre-study indicate that the well-being of truck drivers is influenced by several factors in relation to their work and lifestyle. Based on the results of the questionnaire, working conditions were one of the most negative factors affecting the drivers well-being. From the interviews, this was further investigated and the interviewees indicated that EU regulations regarding their drive-time, cause a great deal of stress.
The factors that stood out as the most prominent were, in descending order: eating habits, sleep, then stress and working conditions. When examining how drivers' eating habits affected their well-being, the results indicated a negative impact on both energy levels and physical health. This is the case despite the fact that drivers largely bring food from home, which indicates that the problem is not solely about access to food, but rather about the circumstances under which it is consumed.
From the questionnaire results, food habits were found to negatively affect energy levels for approximately 50% of the drivers and focus for around 20%. The interviews clarified that, overall, the drivers are satisfied with their professional lifestyle and the routines that come with it.

RQ 2. What are the current eating habits and food handling practices of truck drivers in the truck today?
Based on both the questionnaire and interviews, it appeared that the drivers primarily bring food prepared at home to work. From the interviews, the most common practice in relation to handling food was to simply heat up their lunchboxes in the integrated in the cab. After eating, the most frequent practice was to rinse or quickly dry off the lunchboxes before bringing them home to properly clean them at the end of the work week. Some of the drivers ate out occasionally, but due to high costs and difficulty in planning stops due to EU regulations, they preferred to bring their food in the cab.
The most prominent problems related to eating habits were primarily identified through the interviews. These concerned the difficulty of planning suitable stops along the route in advance, uncertainty regarding the availability of rest stops, limited space in the refrigerator, and the absence of a dedicated place and table to have meals at during breaks.

RQ 3. What needs, wishes, and expectations do drivers have regarding in-cab food-related features and solutions to support healthier habits?
The pre-study shows that the drivers are largely satisfied with the current equipment in the cabin. The interviewees especially highlighted that any more complex cooking methods than microwaves would be undesirable due to an increase in required effort when they mostly just want to keep everything as simple as possible. It would also lead to unwanted food odors in the case of cooking on a stove or with an air fryer as well as additional clean up and required space. The needs and wishes that the drivers brought up were instead targeted towards improving the cab layout rather than adding new appliances. A recurring behavior that was

noted is that drivers regularly move from the driver's seat to the passenger seat during breaks, which indicates a need to mentally and physically separate work from rest. This led to the conclusion that a dedicated lounge area focused on enhancing the eating experience in the cab targets one of the most prevalent customer needs.

An early finding of the study was that truck drivers do not want a kitchen solution in the cab. The project began with a hypothesis that cooking possibilities in the cab were a central user need which later was found to require fundamental revision. The focus shifted from food-related kitchen solutions to the overall living environment in the cab, which proved to be an area where there was a need for improvement. From the pre-study, drivers expressed a high degree of satisfaction with the food-related appliances already present in the cab. The microwave and refrigerator setup were considered more than enough by most interviewees, and very few drivers expressed a desire to replace or supplement them with more advanced cooking equipment. The focus of the concept development was therefore directed toward cab layout and usability rather than the introduction of new food-related support features as first planned. The developed cab layout was based on identified customer needs from the pre-study and was designed to comply with the requirements established by Volvo. The final concept represents a direct response to the findings from the pre-study. By replacing the passenger seat and door with a convertible rear bed and foldable seating group, adapting the dashboard to house a dual fridge setup, introducing an extra storage module with an integrated extendable table, the concept creates a functional lounge and dining space that is physically and experientially distinct from the driving position. The concept takes elements from other automotive areas and reorganizes existing elements into a layout better suited to the realities of long-haul work. The conclusion of this project is that meaningful improvement to driver well-being through cab design is achievable by addressing user needs and looking outside of conventional designs.

11 Recommendations

It is recommended that future studies are conducted by Volvo Trucks, preferably in the form of independent surveys to reach a larger group of long-haul drivers. Such an approach could enable higher response rates as well as a geographical expansion beyond the Nordic countries. Looking outside of Northern Europe could reveal different habits as one of the most prominent findings is that long-haul drivers in the Nordics typically bring food from home due to it being a big part of Nordic culture.

This thesis investigated several areas relating to driver well-being where a number of solutions which warrant further exploration were proposed. These include user interface concepts integrated into the infotainment system, exterior solutions addressing water access and cooking facilities, as well as water-related solutions within the cab interior. Regarding the final concept, it is recommended that the mechanical and electrical solutions necessary to ensure full functionality of the individual modules, e.g. the dashboard, storage module and convertible bed, are subject to further investigation and development. From the ergonomics evaluations, it is also recommended to adjust the dashboard and storage module to improve reachability and use of the modules. This to comply with visibility requirements and optimize living space.

Appendix

Appendix A – Notable features from the CVA

A.1 Hyundai Xcient

Figure A1. Foldable dashboard table from Hyundai XCIENT truck interior, Hyundai Motor Company (n.d)

A.2 IVECO S-way

Figure A2. Fridge with easy access

A.3 MAN TGX

Figure A3. Under bed storage

A.4 Scania S770 G38

Figure A4. Relevant features of Scania S770 G38 interior cabin

A.5 Volvo FH16 Aero XXL

Figure A5. Interior cabin of Volvo FH16 Aero XXL with relevant features

Appendix B – Survey Questions and Results

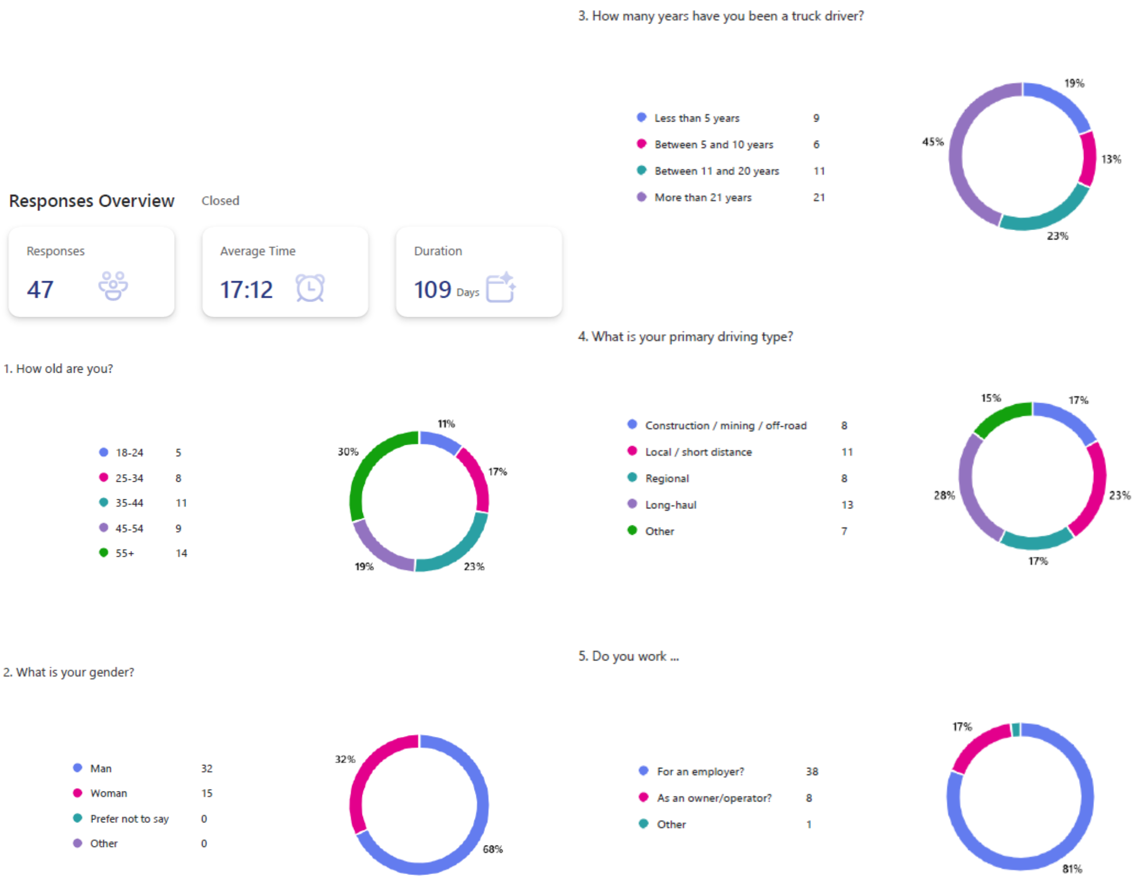


Figure B1. Questions 1 to 5 and corresponding results.

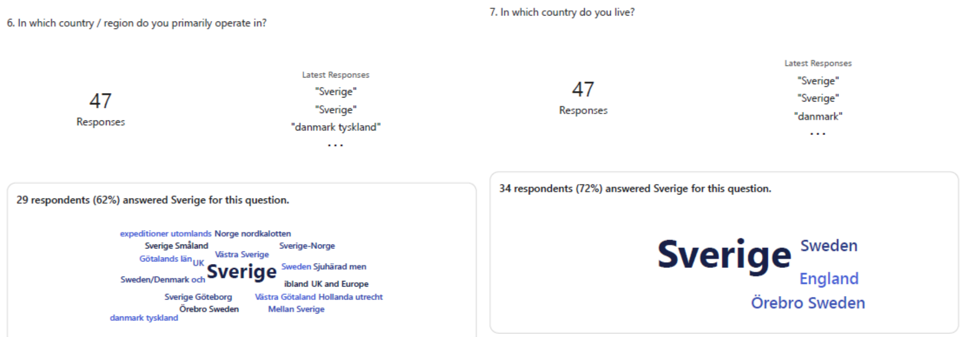


Figure B2. Questions 6 to 7 and corresponding results.

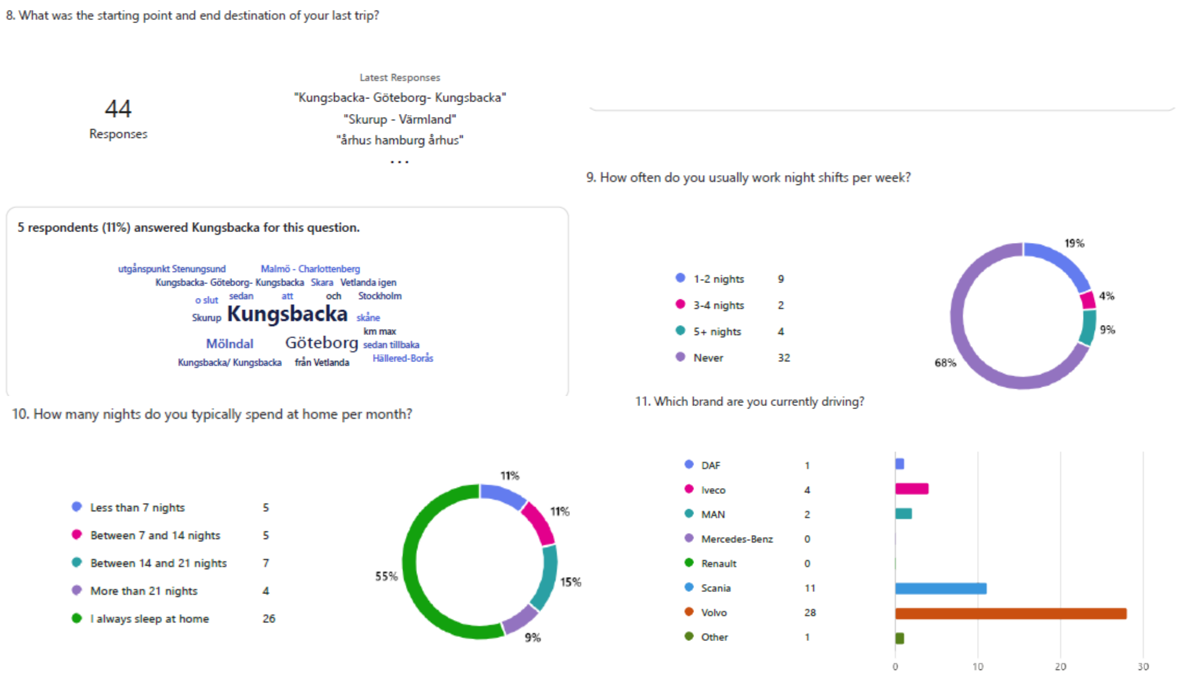


Figure B3. Questions 8 to 11 and corresponding results.

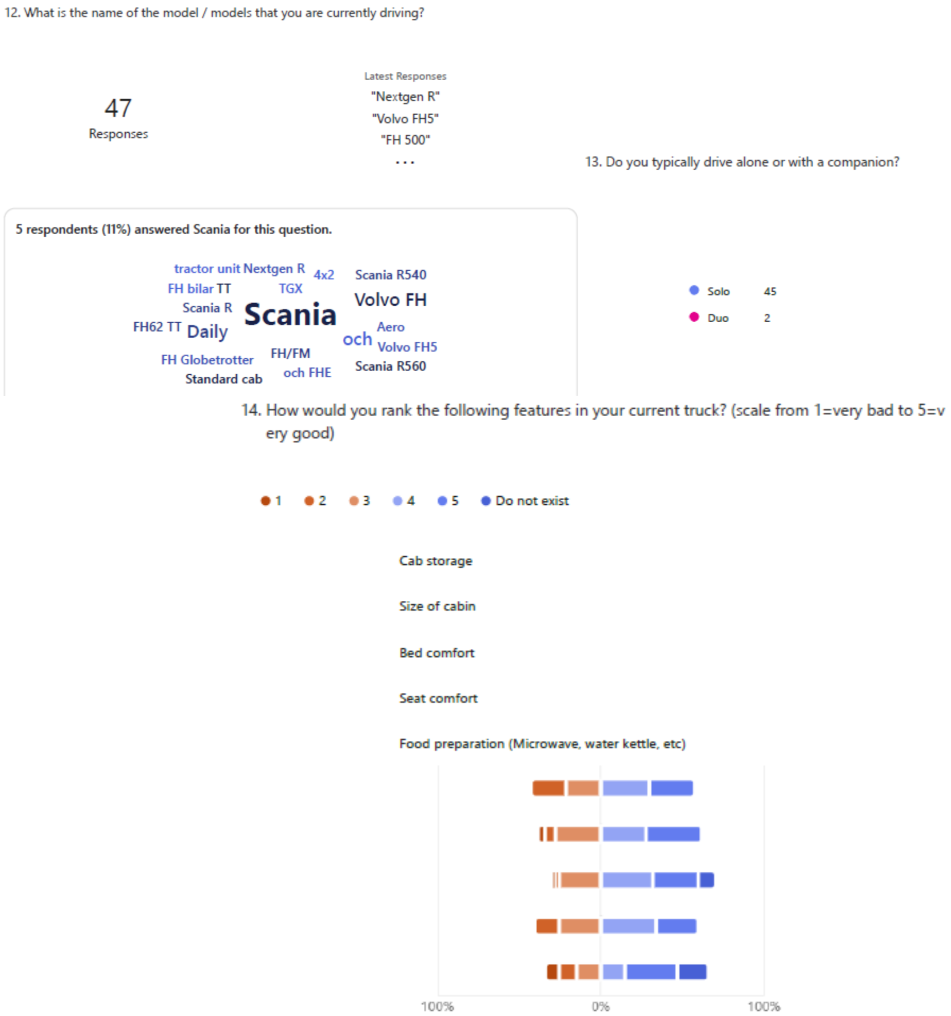


Figure B4. Questions 12 to 14 and corresponding results.

Figure B5. Questions 15 to 18 and corresponding results.

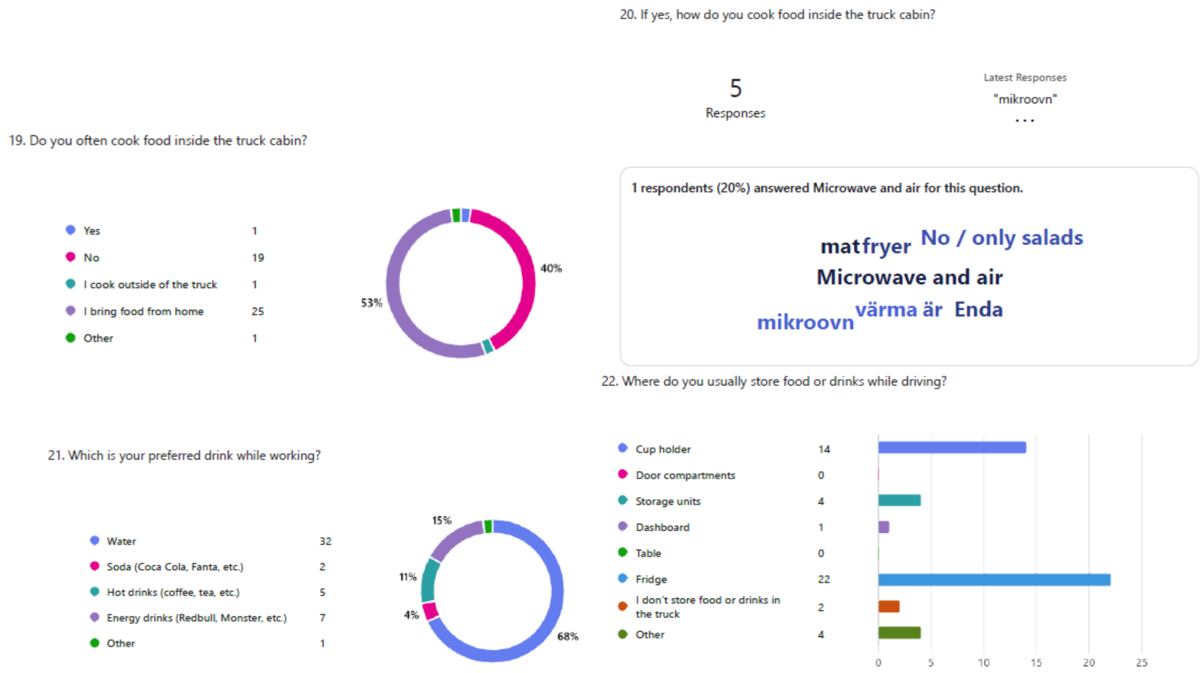


Figure B6. Questions 19 to 22 and corresponding results.

Figure B7. Questions 23 to 26 and corresponding results.

Figure B8. Questions 27 to 31 and corresponding results.

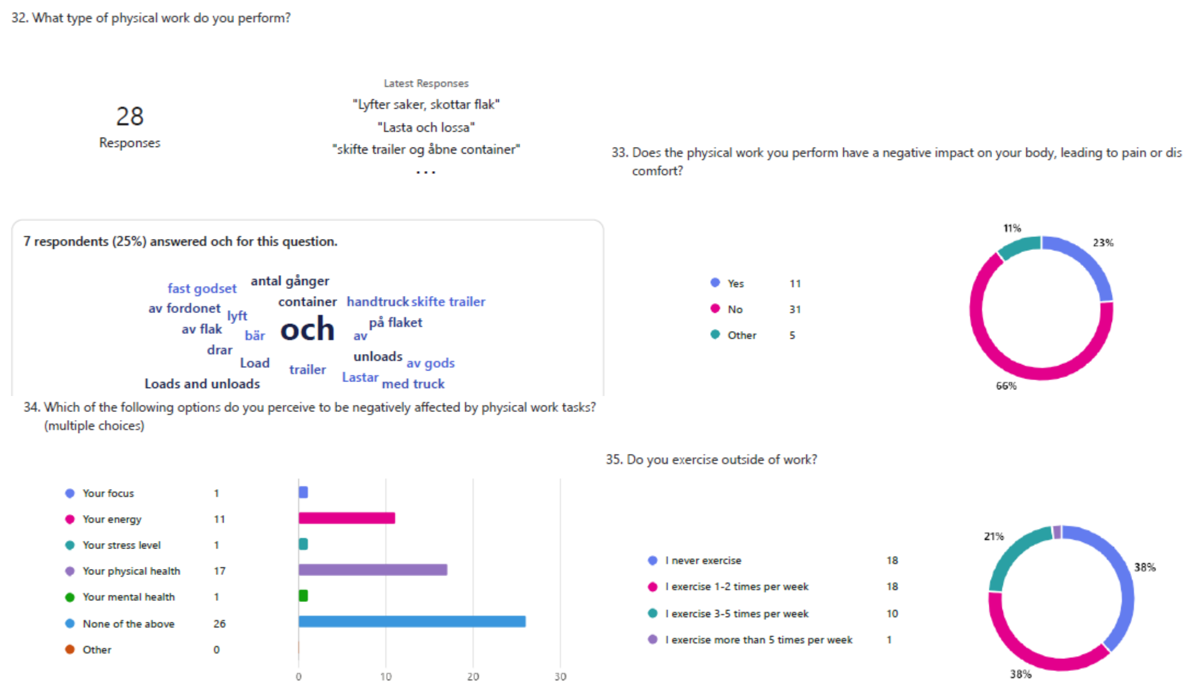


Figure B9. Questions 32 to 35 and corresponding results.

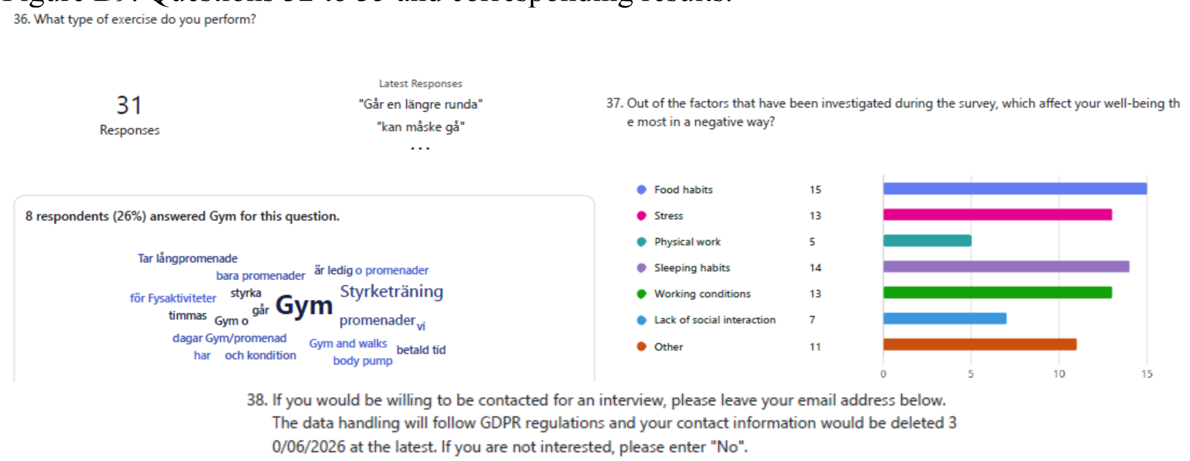


Figure B10. Questions 36 to 38 and corresponding results, excluding question 38.

Appendix C – Interview and Field-Study Templates

Appendix C.1 Interview Template

Purpose

The purpose of this interview is to gather qualitative data on truck drivers' food handling and eating habits while on long-haul missions. The data is gathered to answer the following research questions:

- What are the current eating habits and food handling practices of truck drivers in the truck today?
- What are the biggest perceived problems and barriers related to food, meals, and food-related routines at work as a long-haulage truck driver?
- What needs, wishes, and expectations do drivers have regarding in-cab food-related features and solutions to support healthier habits?

The answers from the interview will be translated into customer needs and wishes to be used for a requirement specification and serve as the foundation for the concept generation phase in the thesis work to Enhance driver well-being through food-related support features.

Interview Structure Overview

Phase	Content	Questions
Introduction	Consent and GDPR compliance	—
Warm-up	Driving profile	1 - 4
General Questions	Daily routine, eating habits, truck setup	5 - 12
Detailed – Branch A	Brings food from home	A13 – A17
Detailed – Branch B	Buys food on the road	B13 – B17
Detailed – Branch C	Cooks in/outside the truck	C13 – C17
Cooling Off	Well-being, improvement ideas, dream setup	18 - 21
Wrap-up	Final comments	22

1. Introduction

Hi and welcome! Thank you for taking the time to help us with this project. This interview will take about 45–60 minutes. We will ask you about your food and eating habits and how they relate to your well-being as a truck driver.

There are no right or wrong answers, we are only interested in your personal experience. You are free to skip any question you do not feel comfortable answering.

Consent and GDPR compliance

Do you consent to us recording and transcribing the meeting? (Teams / online) ☐

Do you consent to us recording the meeting? (In-person) ☐

Do you consent to us storing the data until the end of our project? ☐

Note: All recordings and transcriptions will be deleted no later than 30/06/2026 in accordance with GDPR guidelines about data handling.

The following demographic questions should be answered before the interview:

Field	Response
Age	______________________________
Gender	______________________________
Height & weight	______________________________
Country of residence	______________________________
Countries of operation	______________________________

2. Warm-up

Driving profile

1. How long have you been a truck driver, and how many of those years have you been driving long-haul?

2. Which truck brand and model do you drive most often? Is it assigned to you alone or shared with colleagues?

3. Do you mostly drive alone or together with someone?

↳ *How does this affect your daily work and your eating habits?*

4. How many days per month do you typically spend in the truck, and how often do you work night shifts?

↳ *Flag 'night shifts' and follow up if they say yes.*

3. General Questions

Daily routine & schedule

5. Can you walk me through a typical workday? When do you start, how often do you take breaks, and when do you finish?

↳ *How predictable is this schedule, and how do you prepare if it's unpredictable?*

6. Do you face any constraints such as delivery times, traffic, or regulations that affect when or where you can eat?

↳ *Do you experience a lack in available rest stops or places to park near restaurants?*

Eating habits

7. How many times do you eat or snack during a workday?

↳ *How often do you eat or drink while driving?*

↳ *Do you ever skip meals? If so, why? (Anchor to a concrete recent example if helpful.)*

8. Do your eating habits change when you're working compared to when you're at home? In what ways?

↳ *e.g. more snacks, bigger portions, more fast food, more caffeine?*

Physical well-being

9. Has your work affected you physically in any way?

↳ What kinds of issues, and do you connect them to the truck or to your eating habits? (Approach this with sensitivity.)

Truck food setup

10. What food-related equipment does your truck have? E.g. microwave, fridge/cooler, coffee maker, kettle.

↳ Have you bought or brought any equipment from home — coolers, bins, storage? Have you modified the cab for food handling? Do you experience limitations when it comes to storage?

11. Do you prepare food inside the truck today? E.g. heating, boiling water, or chopping?

↳ How does that process look? Are you satisfied with the current setup? Would you have liked to have running water in the cabin and how would you have used it?

12. Do you mainly bring food from home, buy food while on the road, or cook inside/outside the truck? *Go to the most fitting branch (A, B, or C).*

4. Detailed Questions

A13. What type of food do you usually bring? E.g. home-cooked, frozen, or ready-made?

↳ How long does it typically last you?

A14. How do you store the food in the truck, and how do you heat it if needed?

A15. Why do you prefer bringing food from home rather than buying on the road?

A16. Do you use any specific surface or area in the cab for food preparation such as the dashboard, folded seats, the steering wheel space?

↳ What works well and what is awkward?

↳ Do you bring and store cutlery in the truck? Do you use any special kitchen tools/utensils (spatula, etc).

A17. How do you manage waste such as packaging or food scraps while on the road?

B13. What type of food or drinks do you usually buy and from where? For example, truck stops, supermarkets, restaurants?

↳ Do you usually eat the food inside the truck or where you buy it?

B14. Do you tend to buy the same food, or does it depend on the route you’re driving?

B15. Why do you prefer buying rather than bringing or cooking? Is it related to the truck's preparation options or other reasons?

B16. Do you usually eat alone or with colleagues when eating out?

↳ Do you believe that your eating habits change when you are eating with colleagues?

B17. How do you manage waste from packaging while on the road?

C13. What do you usually cook, and how do you prepare and store the ingredients beforehand?

C14. What does your cooking setup look like and what equipment do you use inside or outside the truck?

↳ *Do you use any improvised surfaces (dashboard, seats)? What works and what is frustrating? Do you make use of public spaces at rest stops to cook food?*

C15. Why do you prefer cooking rather than buying or bringing pre-made food?

C16. How do you manage waste from food preparation?

C17. Do you eat together with others in the cab, or invite people in to share a meal?

↳ *Do you adjust the cabin in any way to accommodate two or more people?*

5. Cooling Off

18. Do you feel that your food and eating habits affect your well-being — positively, negatively, or neutrally?

↳ *What do you believe are the biggest challenges around eating while living in a truck?*

19. Is there anything about your truck model specifically that makes food handling easier or harder?

20. What improvements would you most like to see in the truck regarding food preparation, storage, or handling?

21. If you could redesign the cab from scratch with no limitations, what food-related features would you include?

↳ *Full cooking capability, advanced storage, social/eating space. Show reference images if available. Focus: 'What does your perfect workday look like in terms of food?'*

6. Wrap-up

Summarize the key themes you have heard and confirm your understanding with the interviewee.

22. Is there anything else you would like to add, or anything we have not covered that you feel is important?

Appendix C.2 Field-Study Interview Template

Consent and GDPR

Do you consent to us taking photographs of your truck cabin? ☐

Do you consent to us keeping the answers until the end of the project? ☐

Note: All recordings and photos will be deleted 2026-06-30 at the latest, in accordance with GDPR guidelines regarding data handling.

Questions	Answers
Age	
Height and weight	
Country you live in	
Countries you work in	

1. Is this truck attributed to only you or is it shared with other colleagues?

2. How many days per week do you spend in the truck, and how often do you work night shifts?

3. What are the biggest perceived problems and barriers related to food, meals, and food-related routines at work as a long-haulage truck driver?

3. How do you perceive that your food habits and lifestyle affect your energy levels and focus while working?

4. Do your food habits change while working compared to when you are home?

↳ *Do you primarily bring home-made meals, pre-bought meals or do you buy food along the way?*
↳ *What do you typically tend to cook, how do you prepare it and where do you store the ingredients?*

5. What food-related appliances does the truck you drive have? E.g. microwave, coffee machine, water kettle.
↳ *Have you bought any or brought anything extra from home? E.g. extra fridge, water dispenser, boxes for storage?*

6. Hve you made any food-handling adaptations in your truck cabin?
↳ *How does your food-preparation setup look and what do you use inside or outside the cabin? E.g. barbeque setup during summer, airfryer, etc.*

7. Do you use any specific surfaces or areas in the cabin for food preparation?

↳ *Where in the cabin do you sit/lie to eat?*

8. What improvements would you like to see in the truck cabin when it comes to food preparation, storage, or food handling?
↳ *What works well or poorly with the truck's offering today?*

Appendix D – KJ Analysis

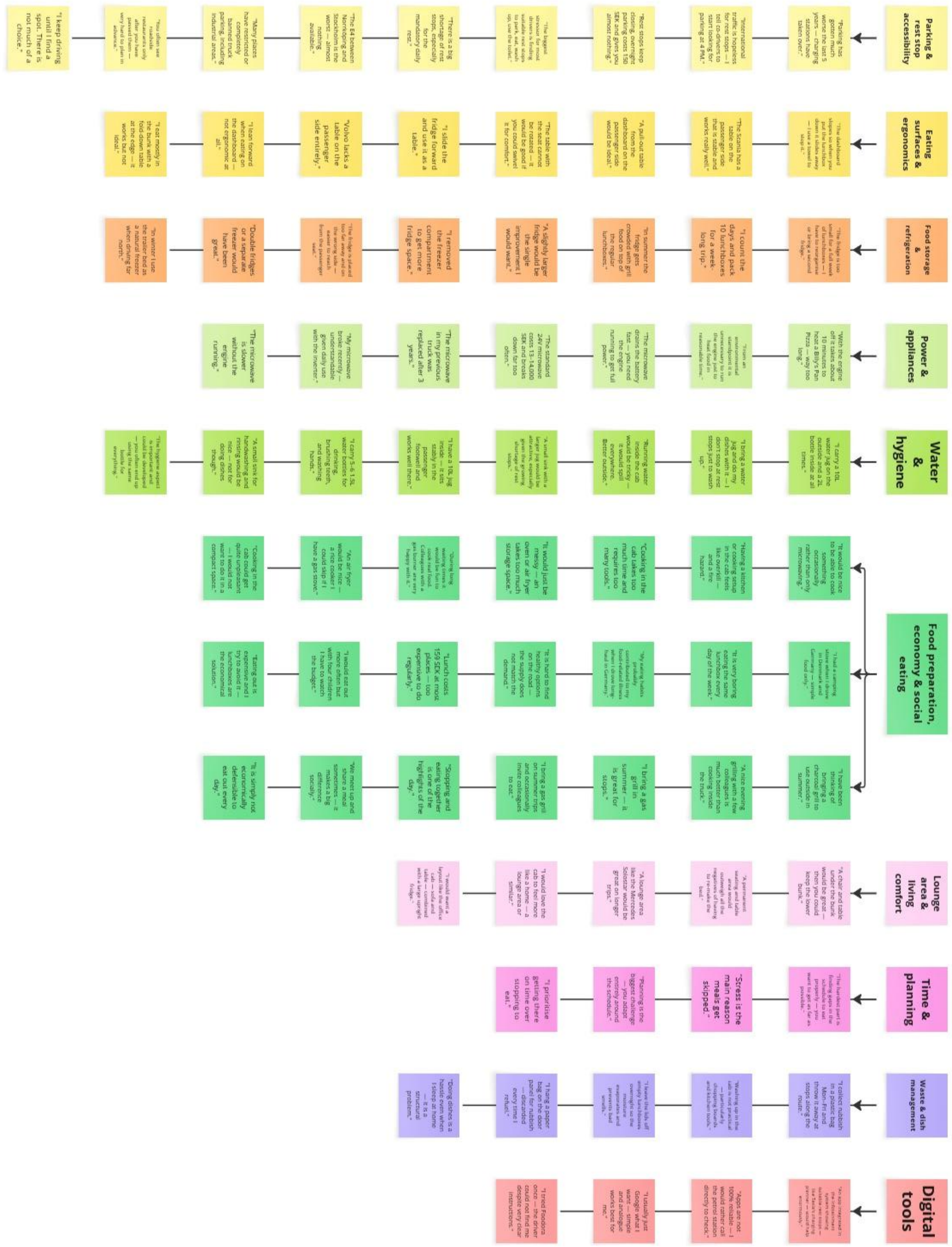


Figure D1. KJ Analysis

Appendix E – Requirement Specification

Requirement specification					
	Criteria	Specified value	Type of Requirement	Verification Method	Justification
	Function(s)				
1	Resting comfort				
1.1	Sleeping height with adjustable top bunk in lowermost position	Confidential	Living	CAD Evaluation	Volvo
1.2	Mattress width	Confidential	Living	CAD Evaluation	Volvo
1.3	Easily cleanable interior	Generic	Living	Material Selection	Volvo
1.4	Access underbunk storage while sitting on the bunk	Generic	Living	Mock-up	Volvo
1.5	Enough space to walk through the cabin	Generic	Living	Mock-up	Volvo
2	Cab construction				
2.1	Luggage lid closing force	Confidential	Technical	CAD Evaluation	Volvo
2.2	Rear wall panel storage, weight of stored items	Confidential	Technical	CAD Evaluation	Volvo
2.3	Passenger seat shall fold to flat (or atleast be perceived as flat)	Generic	Living	CAD Evaluation	Volvo
2.4	Rear wall storage	Generic	Living	CAD Evaluation	Volvo
2.5	Access exterior storage compartments from inside cab	Generic	Living	Mock-up	Volvo
2.6	Cab dimensions	Confidential	Living	Concept Evaluation	Volvo
2.7	Solution must be secured when cab is tilted	Generic	Technical	Concept Evaluation	Volvo
2.8	Pull out drawers without hindrance or clashing with the user	Generic	Technical	CAD Evaluation	Volvo
2.9	Storage capacity interior	Confidential	Living	CAD Evaluation	Volvo
2.10	Storage capacity exterior	Confidential	Living	CAD Evaluation	Volvo
2.11	No sharp edges	Confidential	Safety	CAD Evaluation	Volvo
2.12	Account for integrated microwave	Generic	Safety	Concept Evaluation	Volvo
2.13	Account for integrated coffee machine/water kettle	Generic	Safety	Concept Evaluation	Volvo
2.14	Account for refrigerator drawer	Interior size of: 336W x 367D x 268H [mm]	Living	Concept Evaluation	Pre-study
2.15	Drawer handles under bunk	Minimum width: 95 mm Maximum depth: 50 mm	Technical	Anthropometric Evaluation	Pre-study
3	Ergonomics				
3.1	Simple and intuitive design	Clear symbols	Technical	Concept Evaluation	Pre-study
		Contrast colors (decern in the dark)	Technical	Ergonomic Evaluation	Pre-study
3.2	Usability during driving (F05 - M95)	Generic	Performance	Anthropometric Evaluation	Pre-study
3.3	Usability during standstill (F05 - M95)	Generic	Performance	Anthropometric Evaluation	Pre-study
4	Sustainability				
4.1	Amount of recycled plastics used - interior	Confidential	Technical	Material Selection	Volvo
4.2	Amount of recycled metals used - interior	Confidential	Technical	Material Selection	Volvo
5	Regulations				
5.1	Flammability requirements	Fulfill UN/ECE Regulation 118	Safety	Concept Evaluation	Regulation
5.2	Electrical appliance safety	Fulfill EU 2014/30, EU 2014/35	Safety	Concept Evaluation	Regulation
5.3	General Safety Regulation	Fulfill EU 2019/2144	Safety	Concept Evaluation	Regulation

Figure E1. Requirement Specification

Appendix F – Morphological Matrix

Appendix F.1 Incompatibilities

Category	Sub-solution A	Incompatible with									
Sleep & resting configuration	Extra bunk bed	Standard passenger seat	Single driver	Rotating seats	Between-seat bed table	Dashboard fridge	Stationary table	Raisable table	Adapted underside of bed	Overhead compartment	Additional fridge
	Extra bunk bed (rear)	Raisable table	Single driver	Overhead compartment	Additional fridge	Adapted underside of bed					
	Foldable bed (sections)	Between-seat bed table	Stationary table	Dashboard table	Duo driver	Standard passenger seat					
	Foldable bed (sections, rear)	Additional fridge	Double fridge setup	Large fridge (double standard)							
	Convertible bed (rails)	Duo driver	Dashboard fridge	Raisable table	Adapted underside of bed						
	Convertible bed (rails, rear)	Large fridge (double standard)	Raisable table	Adapted underside of bed							
	Bench seating	Foldable bed (sections)	Foldable bed (sections, rear)								
Seating configuration	Standard passenger seat	Foldable bed (sections)									
	Single driver	Standard passenger seat									
	Duo driver	Single seat									
	Stationary table	Foldable seating group	Standard passenger seat	Rotating seats	Bench seating	Duo driver					
Cold storage	Additional fridge	Extra bunk bed	Overhead compartment	Extra storage module							
	Dishwasher	Double fridge setup	Large fridge (double standard)								
	Dashboard fridge	Adapted dashboard									
Alternative appliances	Dishwasher	Stationary wash basin	Pressurized water tank	Sparkling water dispenser							
Additional storage	Extra storage module	Extra bunk bed	Duo driver	Standard passenger seat	Rotating seats						
	Stationary prep module	Extra storage module									
In-cab meal preparation	Stationary prep module	Stationary wash basin									
	Adapted dashboard	Stationary prep module	Dashboard table								
Eating surfaces	Dashboard table	Adapted dashboard									
	Between-seat bed table	Standard passenger seat									
	Stationary table	Foldable seating group									

Figure F1. Incompatibilities between sub-solutions.

Appendix F.2 Concept Catalogue

#	Passenger side bed	Seating configuration	Cold storage	Additional storage	In-cab meal preparation	Eating surfaces	Driver configuration
1	Convertible bed rear	Single seat	Additional fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
2	Convertible bed rear	Single seat	Additional fridge	Under bed storage	Adapted dashboard	Dashboard table	Single driver
3	Convertible bed rear	Single seat	Additional fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
4	Convertible bed rear	Single seat	Dashboard fridge	Overhead compartment	Adapted dashboard	Extendable table	Single driver
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172	Foldable bed passenger side	Single seat	Additional fridge	Under bed storage	Adapted underside of bed	Extendable table	Single driver
173	Foldable bed passenger side	Single seat	Additional fridge	Under bed storage	Adapted underside of bed	Foldable table	Single driver
174	Foldable bed passenger side	Single seat	Additional fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
175	Foldable bed passenger side	Single seat	Additional fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
176	Foldable bed passenger side	Single seat	Dashboard fridge	Overhead compartment	Adapted underside of bed	Extendable table	Single driver
177	Foldable bed passenger side	Single seat	Dashboard fridge	Overhead compartment	Adapted underside of bed	Foldable table	Single driver
178	Foldable bed passenger side	Single seat	Dashboard fridge	Overhead compartment	Adapted dashboard	Extendable table	Single driver
179	Foldable bed passenger side	Single seat	Dashboard fridge	Overhead compartment	Adapted dashboard	Foldable table	Single driver
180	Foldable bed passenger side	Single seat	Dashboard fridge	Under bed storage	Adapted underside of bed	Extendable table	Single driver
181	Foldable bed passenger side	Single seat	Dashboard fridge	Under bed storage	Adapted underside of bed	Foldable table	Single driver
182	Foldable bed passenger side	Single seat	Dashboard fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
183	Foldable bed passenger side	Single seat	Dashboard fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
184	Foldable bed passenger side	Single seat	Dashboard fridge	Extra storage module	Adapted underside of bed	Extendable table	Single driver
185	Foldable bed passenger side	Single seat	Dashboard fridge	Extra storage module	Adapted underside of bed	Foldable table	Single driver
186	Foldable bed passenger side	Single seat	Dashboard fridge	Extra storage module	Adapted dashboard	Extendable table	Single driver
187	Foldable bed passenger side	Single seat	Dashboard fridge	Extra storage module	Adapted dashboard	Foldable table	Single driver
188	Foldable bed passenger side	Single seat	Standard fridge	Overhead compartment	Adapted underside of bed	Extendable table	Single driver
189	Foldable bed passenger side	Single seat	Standard fridge	Overhead compartment	Adapted underside of bed	Foldable table	Single driver
190	Foldable bed passenger side	Single seat	Standard fridge	Overhead compartment	Adapted dashboard	Extendable table	Single driver
191	Foldable bed passenger side	Single seat	Standard fridge	Overhead compartment	Adapted dashboard	Foldable table	Single driver
192	Foldable bed passenger side	Single seat	Standard fridge	Under bed storage	Adapted underside of bed	Extendable table	Single driver
193	Foldable bed passenger side	Single seat	Standard fridge	Under bed storage	Adapted underside of bed	Foldable table	Single driver
194	Foldable bed passenger side	Single seat	Standard fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
195	Foldable bed passenger side	Single seat	Standard fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
196	Foldable bed passenger side	Single seat	Standard fridge	Extra storage module	Adapted underside of bed	Extendable table	Single driver
197	Foldable bed passenger side	Single seat	Standard fridge	Extra storage module	Adapted underside of bed	Foldable table	Single driver
198	Foldable bed passenger side	Single seat	Standard fridge	Extra storage module	Adapted dashboard	Extendable table	Single driver
199	Foldable bed passenger side	Single seat	Standard fridge	Extra storage module	Adapted dashboard	Foldable table	Single driver
200	Foldable bed passenger side	Foldable seating group	Additional fridge	Under bed storage	Adapted underside of bed	Extendable table	Single driver
201	Foldable bed passenger side	Foldable seating group	Additional fridge	Under bed storage	Adapted underside of bed	Foldable table	Single driver
202	Foldable bed passenger side	Foldable seating group	Additional fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
203	Foldable bed passenger side	Foldable seating group	Additional fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
204	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Overhead compartment	Adapted underside of bed	Extendable table	Single driver
205	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Overhead compartment	Adapted underside of bed	Foldable table	Single driver
206	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Overhead compartment	Adapted dashboard	Extendable table	Single driver
207	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Overhead compartment	Adapted dashboard	Foldable table	Single driver
208	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Under bed storage	Adapted underside of bed	Extendable table	Single driver
209	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Under bed storage	Adapted underside of bed	Foldable table	Single driver
210	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
211	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
212	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Extra storage module	Adapted underside of bed	Extendable table	Single driver
213	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Extra storage module	Adapted underside of bed	Foldable table	Single driver
214	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Extra storage module	Adapted dashboard	Extendable table	Single driver
215	Foldable bed passenger side	Foldable seating group	Dashboard fridge	Extra storage module	Adapted dashboard	Foldable table	Single driver
216	Foldable bed passenger side	Foldable seating group	Standard fridge	Overhead compartment	Adapted underside of bed	Extendable table	Single driver
217	Foldable bed passenger side	Foldable seating group	Standard fridge	Overhead compartment	Adapted underside of bed	Foldable table	Single driver
218	Foldable bed passenger side	Foldable seating group	Standard fridge	Overhead compartment	Adapted dashboard	Extendable table	Single driver
219	Foldable bed passenger side	Foldable seating group	Standard fridge	Overhead compartment	Adapted dashboard	Foldable table	Single driver
220	Foldable bed passenger side	Foldable seating group	Standard fridge	Under bed storage	Adapted underside of bed	Extendable table	Single driver
221	Foldable bed passenger side	Foldable seating group	Standard fridge	Under bed storage	Adapted underside of bed	Foldable table	Single driver
222	Foldable bed passenger side	Foldable seating group	Standard fridge	Under bed storage	Adapted dashboard	Extendable table	Single driver
223	Foldable bed passenger side	Foldable seating group	Standard fridge	Under bed storage	Adapted dashboard	Foldable table	Single driver
224	Foldable bed passenger side	Foldable seating group	Standard fridge	Extra storage module	Adapted underside of bed	Extendable table	Single driver
225	Foldable bed passenger side	Foldable seating group	Standard fridge	Extra storage module	Adapted underside of bed	Foldable table	Single driver
226	Foldable bed passenger side	Foldable seating group	Standard fridge	Extra storage module	Adapted dashboard	Extendable table	Single driver
227	Foldable bed passenger side	Foldable seating group	Standard fridge	Extra storage module	Adapted dashboard	Foldable table	Single driver

Figure F2. Full Concept Catalogue.

Appendix G – Concept Evaluation

Appendix G.1 Elimination Matrix

(+) Fulfills criteria
(-) Does not fulfill criteria
(?) More info needed

Continue
Remove
Test

Solution alternative	Lounge Quality	Ergonomic Usability	Food Handling Capability	Implementability	Storage Efficiency	Spatial Efficiency	Decision
1	-						Remove
2	-						Remove
3	-						Remove
4	-						Remove
5	-						Remove
6	-						Remove
7	-						Remove
8	-						Remove
9	-						Remove
10	-						Remove
11	-						Remove
12	-						Remove
13	-						Remove
14	-						Remove
15	-						Remove
16	-						Remove
17	-						Remove
18	-						Remove
19	-						Remove
20	-						Remove
21	-						Remove
22	+	+	+	+	-		Remove
23	+	+	+	+	-		Remove
24	+	+	+	+	-		Remove
25	+	+	+	+	+	-	Remove
26	+	+	+	+	-		Remove
27	+	+	+	+	+	-	Remove
28	+	+	+	+	-		Remove
29	+	+	+	+	-		Remove
30	+	+	+	+	-		Remove
31	+	+	+	+	+		Remove
32	+	+	+	+	-		Remove
33	+	+	+	+	+	-	Remove
34	+	+	+	+	+	-	Remove
35	+	+	+	+	-		Remove
36	+	+	+	+	+	-	Remove
37	+	+	+	+	-		Remove
38	+	+	+	+	-		Remove
39	+	+	+	+	-		Remove
40	+	+	+	+	+	-	Remove
41	+	+	+	+	-		Remove
42	+	+	+	+	+	-	Remove
43	+	+	+	+	-		Remove
44	+	+	+	+	-		Remove
45	+	+	+	+	-		Remove
46	+	+	+	+	+	-	Remove
47	+	+	+	+	-		Remove
48	+	+	+	+	+	-	Remove
49	+	+	+	+	-		Remove
50	+	+	+	+	-		Remove
51	+	+	+	+	-		Remove
52	+	+	+	+	+	+	Continue
53	+	+	+	+	-		Remove
54	+	+	+	+	+	+	Continue
55	+	+	+	+	+	-	Remove
56	+	+	+	+	-		Remove
57	+	+	+	+	+	-	Remove
58	+	+	+	+	-		Remove
59	+	+	+	+	-		Remove
60	+	+	+	+	-		Remove
61	+	+	+	+	+	+	Continue
62	+	+	+	+	-		Remove
63	+	+	+	+	+	+	Continue
64	-						Remove
65	-						Remove
66	-						Remove
67	-						Remove
68	-						Remove
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70	-						Remove
71	-						Remove
72	-						Remove
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100	+	-					Remove
101	+	-					Remove
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103	+	+	+	+	+	-	Remove
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105	+	+	+	+	+	-	Remove
106	+	-					Remove
107	+	-					Remove
108	+	-					Remove
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111	+	+	+	+	+	+	Continue
112	+	-					Remove
113	+	-					Remove
114	+	-					Remove
115	+	+	+	+	+	+	Continue
116	+	+	+	+	-		Remove
117	+	+	+	+	+	+	Continue
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119	+	-					Remove
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121	+	+	+	+	+	-	Remove
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124	+	-					Remove
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128	+	+	+	+	-		Remove
129	+	+	+	+	+	+	Continue
130	+	-					Remove
131	+	-					Remove
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133	+	+	+	+	+	+	Continue
134	+	+	+	+	-		Remove
135	+	+	+	+	+	+	Continue
136	-						Remove
137	-						Remove
138	-						Remove
139	-						Remove
140	-						Remove
141	-						Remove
142	-						Remove
143	-						Remove
144	-						Remove
145	-						Remove
146	-						Remove
147	-						Remove
148	+	+	+	-			Remove
149	+	+	+	-			Remove
150	+	+	+	-			Remove
151	+	+	+	-			Remove
152	+	+	+	-			Remove
153	+	+	+	-			Remove
154	+	+	+	-			Remove
155	+	+	+	-			Remove
156	+	+	+	-			Remove
157	+	+	+	-			Remove
158	+	+	+	-			Remove
159	+	+	+	-			Remove
160	+	+	+	-			Remove
161	+	+	+	-			Remove
162	+	+	+	-			Remove
163	+	+	+	-			Remove
164	+	+	+	-			Remove
165	+	+	+	-			Remove
166	+	+	+	-			Remove
167	+	+	+	-			Remove
168	+	+	+	-			Remove
169	+	+	+	-			Remove
170	+	+	+	-			Remove
171	+	+	+	-			Remove
172	-						Remove
173	-						Remove
174	-						Remove
175	-						Remove
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177	-						Remove
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192	-						Remove
193	-						Remove
194	-						Remove
195	-						Remove
196	-						Remove
197	-						Remove
198	-						Remove
199	-						Remove
200	+	-					Remove
201	+	-					Remove
202	+	+	+	+	+	+	Continue
203	+	+	+	+	+	+	Continue
204	+	-					Remove
205	+	-					Remove
206	+	+	+	+	+	-	Remove
207	+	+	+	+	+	-	Remove
208	+	-					Remove
209	+	-					Remove
210	+	+	+	+	+	+	Continue
211	+	+	+	+	+	+	Continue
212	+	-					Remove
213	+	-					Remove
214	+	+	+	+	+	+	Continue
215	+	+	+	+	+	+	Continue
216	+	-					Remove
217	+	-					Remove
218	+	+	+	+	+	-	Remove
219	+	+	+	+	+	-	Remove
220	+	-					Remove
221	+	-					Remove
222	+	+	+	+	+	+	Continue
223	+	+	+	+	+	+	Continue
224	+	-					Remove
225	+	-					Remove
226	+	+	+	+	+	+	Continue
227	+	+	+	+	+	+	Continue

Figure G1. Elimination matrix.

Appendix G.2 Pugh Matrix

Pugh Matrix First Iteration Concepts / Criteria	Volvo FH16 Aero XXL	Concept 52	Concept 54	Concept 61	Concept 63	Concept 109	Concept 111	Concept 115	Concept 117	Concept 127	Concept 129	Concept 133	Concept 135	Concept 202	Concept 203	Concept 210	Concept 211	Concept 214	Concept 215	Concept 222	Concept 223	Concept 226	Concept 227
Perceived lounge quality	R	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Driver adoption	E	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Resting configuration	F	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ease of drive-to-rest transition	E	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Complexity of construction	R	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Meal preparation capability	E	+	+	+	+	+	+	+	+	0	0	+	+	+	+	+	+	+	+	0	0	+	+
Eating space quality	N	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Storage capacity	C	+	+	+	+	0	0	+	+	0	0	+	+	0	0	0	0	+	+	0	0	+	+
Cold storage capacity	E	+	+	0	0	+	+	+	+	0	0	0	0	+	+	+	+	+	+	0	0	0	0
Walkthrough clearance		+	+	+	+	+	+	+	+	0	+	+	+	0	0	0	0	0	0	0	0	0	0
∑ +	0	9	9	8	8	8	8	9	9	7	7	8	8	7	7	7	7	7	7	5	5	7	7
∑ -	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
∑ 0	0	0	0	1	1	1	1	0	0	4	3	1	1	2	2	2	2	1	1	4	4	2	2
Total Sum	0	8	8	7	7	7	7	8	8	6	6	7	7	6	6	6	6	6	6	4	4	6	6

Figure G2. Pugh Matrix – first iteration.

Pugh Matrix Second Iteration Concepts / Criteria	Concept 52	Volvo FH16 Aero XXL	Concept 54	Concept 61	Concept 63	Concept 109	Concept 111	Concept 115	Concept 117	Concept 127	Concept 129	Concept 133	Concept 135	Concept 202	Concept 203	Concept 210	Concept 211	Concept 214	Concept 215	Concept 222	Concept 223	Concept 226	Concept 227
Perceived lounge quality		-	-	-	0	-	0	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
Driver adoption	R	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resting configuration	E	-	0	0	0	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ease of drive-to-rest transition	F	-	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Complexity of construction	E	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-	0	+	+	0	+	+
Meal preparation capability	R	-	0	0	0	-	-	0	0	-	-	0	0	-	-	-	-	0	0	-	-	0	0
Eating space quality	E	-	+	0	+	0	+	0	+	0	+	0	+	-	0	-	0	-	0	-	0	-	0
Storage capacity	N	-	0	0	0	0	0	+	+	0	0	+	+	-	-	-	-	0	0	-	-	0	0
Cold storage capacity	C	-	0	-	-	-	-	0	0	-	-	-	-	0	0	-	-	0	0	-	-	-	-
Walkthrough clearance	E	-	-	0	-	0	-	-	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-
∑ +	0	1	2	1	2	2	3	4	4	2	3	4	4	1	1	1	1	1	2	3	1	2	2
∑ -	0	9	3	2	3	5	5	3	4	5	6	3	5	8	7	9	8	4	4	6	6	5	5
∑ 0	0	0	6	7	5	3	2	3	2	3	1	3	1	1	2	0	1	4	4	1	2	2	3
Total Sum	0	-8	-1	-1	-1	-3	-2	1	0	-3	-3	1	-1	-7	-6	-8	-7	-3	-2	-3	-5	-3	-3

Figure G3. Pugh Matrix – second iteration.

Pugh Matrix Third Iteration Concepts / Criteria	Concept 115	Volvo FH16 Aero XXL	Concept 52	Concept 54	Concept 61	Concept 63	Concept 109	Concept 111	Concept 117	Concept 127	Concept 129	Concept 133	Concept 135	Concept 202	Concept 203	Concept 210	Concept 211	Concept 214	Concept 215	Concept 222	Concept 223	Concept 226	Concept 227
Perceived lounge quality		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Driver adoption	R	-	+	0	+	0	0	-	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-
Resting configuration	E	-	-	-	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ease of drive-to-rest transition	F	-	+	+	+	+	0	0	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-
Complexity of construction	E	+	-	0	0	+	-	0	+	0	+	+	+	-	0	-	-	-	0	-	0	-	0
Meal preparation capability	R	-	0	0	0	0	-	-	0	-	-	0	0	-	-	-	-	0	0	-	-	0	0
Eating space quality	E	-	0	+	0	+	0	+	+	0	+	0	+	-	0	-	0	-	0	-	0	-	0
Storage capacity	N	-	-	-	-	-	-	-	0	-	-	0	0	-		-	-	-	-	-	-	-	-
Cold storage capacity	C	-	0	0	-	-	-	-	0	-	-	-	-	0	0	-	-	0	0	-	-	-	-
Walkthrough clearance	E	-	+	0	+	0	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-
∑ +	0	1	3	2	3	3	0	1	2	0	2	1	2	0	0	0	0	0	0	0	0	0	0
∑ -	0	9	4	3	4	4	6	6	3	5	6	2	4	7	6	8	8	4	5	8	7	7	6
∑ 0	0	0	3	5	3	3	4	3	5	5	2	7	4	3	4	2	2	6	5	2	3	3	4
Total Sum	0	-8	-1	-1	-1	-1	-6	-5	-1	-5	-4	-1	-2	-7	-6	-8	-8	-4	-5	-8	-7	-7	-6
Decision	Continue	Remove	Continue	Remove	Remove	Continue	Remove	Remove	Remove	Remove	Remove	Continue	Remove	Remove	Remove	Remove	Remove	Remove	Continue	Remove	Remove	Remove	Remove

Figure G4. Pugh Matrix – third iteration

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